



National Research
Council Canada

Conseil national
de recherches Canada

**Regional
Innovation
Forum**

Vision to 2006: Innovative Emerging Technology Clusters for Regional Economic Growth

Roundtable VII Report

April 8 – 9, 2002
Fairmont Chateau Laurier, Ottawa

i n n o v a t i o n

Canada



Regional Innovation Forum - Ottawa

Roundtable VII Report

VISION TO 2006: INNOVATIVE EMERGING
TECHNOLOGY CLUSTERS FOR REGIONAL
ECONOMIC GROWTH

Edited by Arvind Chhatbar

Roundtable VII organized by
The National Research Council of Canada
in cooperation with the
Ottawa Economic Development Corporation (OEDC)
Ottawa Centre for Research and Innovation (OCRI)
and the
Ottawa Life Sciences Council (OLSC)

April 8 - 9, 2002
Fairmont Chateau Laurier, Ottawa

Canadian Cataloguing in Publication Data

Main entry under title:

Vision to 2006: Innovative Emerging Technology Clusters
for Regional Economic Growth

At head of title: Roundtable VII Report, Regional Innovation Forum,
April 8-9, 2002 Fairmont Chateau Laurier Hotel, Ottawa

1. High technology industries – Ontario – Ottawa Region.
2. Life sciences – Research – Ontario – Ottawa Region.
3. Environmental sciences – Research – Ontario – Ottawa Region.
4. Biotechnology – Ontario – Ottawa Region.
5. Environmental engineering – Ontario – Ottawa Region.

I. National Research Council of Canada, Regional Innovation Centre – Ottawa

NR16-67/2003E

0-662-33409-4

Foreword/Introduction

This year marks the Seventh Regional Innovation Forum Roundtable – Ottawa (RIF-O), part of a series of roundtables held to promote technology-based growth in the region. It also marks the RIF-O's second awards night, which provides an excellent opportunity to celebrate this region's innovators and innovations.

Once again, I wish to extend my thanks to our regulator collaborators, the Ottawa Centre for Research and Innovation and the Ottawa Life Sciences Council. I would also like to acknowledge the sponsors of this year's event:

- Technology Partnerships Canada
- The Ottawa Citizen
- Carleton University
- Communications and Information Technology Ontario
- inMedia
- Non-Linear Creations
- Ville de Gatineau
- The Portables
- Industry Canada
- The Alloy Group
- CBC Radio-Canada
- The City of Ottawa
- General Assembly Production Centre
- Keystep Growth & Finance
- TATA Consultancy Services
- Vitesse Re-Skilling Canada Inc.

The Roundtable was a one-day event, consisting of a plenary session of speakers and afternoon workshops. This report summarizes the various presentations, discussions, and recommendations resulting from the sessions.

I hope this report – along with past reports – will provide insight into the upcoming opportunities for growth as well as the process of regional innovation in Ottawa.

In conclusion, I would like to thank this year's participants for their contribution to the Roundtable and the members of the Regional Innovation Forum, who have devoted themselves to implementing the recommendations of the roundtables.

Mr. Arvind Chhatbar

Executive Director, Regional Innovation Forum – Ottawa
National Research Council Canada
President, Vitesse Re-Skilling Canada Inc.

Table of Contents

Foreword/Introduction	iii
Welcome – Arvind Chhatbar, Executive Director, Regional Innovation Forum	1
Honourable Walt Lastewka, Member of Parliament	5
Welcome by Co-Chairs	
Dr. Arthur Carty, President, National Research Council Canada	9
Kirk Mandy, Vice-Chair, Zarlink Semiconductor	15
Key Note Presentations	17
Douglas Mulhall, Author, <i>Our Molecular Future</i>	17
Dr. Alan Bernstein, President, Canadian Institutes of Health Research	31
Dr. Brian Underdown, Vice-President, Science & Technology, MDS Capital Corp.	45
Dr. Adam Chowanec, Chairman, Tundra Semiconductor	51
Dr. Martin Sumner-Smith, Vice-President, Pharmaceutical Solutions, OpenText Corporation	57
Arup Gupta, President, TCS-America, USA	67
Eli Turk, Vice-President, Business Development, Alcatel Canada	71
Summary of Recommendations/Issues for Possible Action	77
Workshop 1:	
Nascent Clusters: Genomics, Bioinformatics & Nanotechnology	77
Workshop 2:	
Vital Growth Strategies: Photonics, Wireless, Fabless Semiconductor	82
Appendix A: Roundtable VII Agenda	87
Appendix B: Regional Innovation Awards Celebration	91
Appendix C: Roundtable Participants	95

Welcome

Arvind Chhatbar

Executive Director, Regional Innovation Forum – Ottawa

Mr. Chhatbar is Director of the National Research Council of Canada's (NRC) Regional Innovation Centre – Ottawa and President of Vitesse (Re-Skilling) Canada Inc. He is also the Executive Director of the Ottawa Regional Innovation Forum, which brings together leaders from business, government, universities, financial institutions and economic development organizations to discuss issues of concern to the region and remove barriers to innovation. He has pioneered the creation of employee-owned spin-off companies at NRC. He has helped create SiGe Microsystems Inc, Toth Information Systems Inc., CrossLight Software Inc., Ocell Inc., and Iridian Spectral Technologies.

Mr. Chhatbar has significant business experience in the field of technology commercialization. He has successfully spearheaded a number of new initiatives such as creating the technology licensing section at NRC, developing operating procedures for management of intellectual property, coordinating biotechnology-related business activities as well as developing a regional innovation system for the National Capital Region. Vitesse (Re-Skilling) Canada Inc. received the Chrysler Award of Excellence and substantial support from the Ontario government for the Vitesse program. Mr. Chhatbar has also received Outstanding Achievement Awards. He holds two post-graduate degrees in public and business administration and is a professional banker having served in senior capacities in one of the top 500 banks of the world.

- Bonjour à tous! Bienvenue à notre septième Table ronde du Forum régional de l'innovation. Good morning ladies and gentlemen and welcome to our seventh Regional Innovation Forum Roundtable.
- With a thought provoking presentation last evening by Mike Lazaridis, stressing the importance of science and education for growth, aiming to become the wisest nation, I think we are set today to start some wise discussions.
- The seventh Roundtable, in many ways, reminds me of the first Roundtable when we were attempting to encourage innovation and technology-based entrepreneurial growth in this region. It is similar because the past year has brought dramatic changes – changes demanding that we re-ignite growth and find new ways to generate development and economic growth. The theme of this year's Roundtable was chosen with this in mind. New opportunities and emerging technologies will provide renewal of the technology-based growth. These Innovation roundtables are a way to discuss the economic potential of new technology, increase awareness of the opportunities, and make recommendations that would force growth.
- Those who are here and were involved in the first Innovation roundtable in 1996 should feel proud that this notion of innovation roundtables is now a common phenomenon across the country and is actively encouraged by governments at all levels. We hear about innovation summits and roundtables all over the place and without much bragging it can be said that we started it here in Ottawa. As one well-known local writer, Tony Patterson, put it: "the Regional Innovation Forum is the granddaddy of innovation

conferences." This seventh year could be the beginning of a new cycle of renewal by identifying new emerging technology clusters for future growth.

- The ideas and issues discussed here have served as an impetus for action not only by the Regional Innovation Forum itself, but by the community at large. This is perhaps the Roundtable's single most important strength. Here in Ottawa, we developed a spirit of encouraging and supporting one another's activities. This is one of the reasons for the success of the region's fast growth. It is in keeping with the spirit of innovation. Innovation is a community responsibility and it is the actions taken by the community that make change happen.
- While there are a number of examples of community activity as a result of the roundtable discussions, I'd like to highlight some of the actions of the Regional Innovation Forum itself. In addition to the Vitesse program, these outcomes include streamlining administrative procedures for scientific research and experimental tax credits, changing the rules on capital gains tax, and the relaxation of immigration rules. In addition, we have played a role in the building of NRC's Industrial Partnership Facility, the creation of the 'spinoffcentre.com' Web site, and the early work on creating technology clusters in the Ottawa region. We have also helped create new strategic marketing programs and highlighted their importance to the technology-based sector.
- In the Forum, we've deliberately chosen not to take credit for such achievements. Rather, the fundamental purpose has been to foster innovation and change and to allow members of the community to take ownership and initiate change. Change occurs through the actions of committed individuals. A number of people in our community – indeed, in this room – deserve credit for the successes of the Forum. Aujourd'hui, le fait que le Conseil national de recherches et autres organismes, utilisent le format de la table ronde dans des endroits tels que Halifax, le Nouveau-Brunswick, Vancouver, Saskatoon, Edmonton, l'Okanagan et à Victoria, pour en nommer quelques-uns, est une indication que le concept fonctionne bien.
- Since innovation is now the talk of the nation, perhaps the current challenge is "what do we do next to distinguish ourselves?" Thus, we've chosen to focus this year's Roundtable on some of the issues we are now facing.

- With the dramatic global changes that occurred over the last year and the structural changes here in our city, it is appropriate that we look to identify where new opportunities lie. We cannot wait to see when an economic turnaround will bring us to the brighter days seen in the past. We believe this is no time to put things on hold – in fact it is perhaps time to take hold of the future and to recreate it.

- Our future lies in the ability to identify and embrace new technologies and emerging trends that are likely to transform our world. The discussions at this roundtable will highlight opportunities on the horizon and how we can take advantage of them. You'll hear a broad spectrum of views of potential applications of emerging technologies and their wide-ranging impacts. That is not to suggest that we'll see a resurgence of economic growth as we experienced in our recent past, although one cannot discount the possibility. But there are numerous opportunities that can provide an impetus for significant growth. We've already witnessed venture capitalists shifting investment decisions from a predominant focus in telecommunications sectors to include broader and wider consideration of investments in the biotech and life sciences sectors.

- Albeit, under more stringent conditions than in the past, this Roundtable is therefore an opportunity to focus on nascent clusters, and to strengthen our competitive position in Ottawa and in Canada. Ceci sera le thème des sessions plénières et discussions dans les ateliers cet après-midi. This will be the theme of the plenary sessions and workshop discussions today. Later in the evening, we will continue the tradition started two years ago of recognizing our innovators and innovations. We hope that you will be able to join us for the awards gala dinner at the end of today's session.

Honourable Walt Lastewka

Member of Parliament – St. Catharines, Ontario

A former General Motors senior executive, Walt Lastewka was first elected to the House of Commons in 1993, then re-elected in 1997 and 2000. He has served on the Joint House, Senate, Foreign Affairs and International Trade, and the Environment Committees, and is presently Chair of the Standing Committee on Industry, Science and Technology. Mr. Lastewka has been appointed to posts on three occasions: Chair of the Task Force on Commercializing Government Science Research (1996-97); Parliamentary Secretary to the Ministry of Industry (1997-99); and, advocate in the federal caucus for small and medium-sized enterprises (SMEs) (March 2000-present). These posts are an indication of the respect he has earned in Parliament and from Prime Minister Jean Chrétien.

Mr. Lastewka actively promotes SME infrastructure development through the Niagara Canada community investment plan, which includes SME financial workshops, the Niagara Virtual Business Accelerator, and activities designed to improve trade through SMEs. He is currently interested in the concept of using local social capital to develop the small business infrastructure in communities.

- Good morning and welcome on behalf of the Government of Canada. It is, of course, wonderful to have this venue to discuss innovation in Canada. Just over a month ago, the Government released Canada's Innovation Paper for discussion and for much debate over the next number of months in order that we together can decide on what the innovation strategy should be for Canada.
- The Innovation Strategy makes it clear that we have a challenge before us and we must work together to get it right. But Canada does have innovation strengths and therefore a good base to build upon. For example, we lead the industrialized world in many ways, such as the rate of which our publicly funded research produces spin-off firms and new businesses. As participants in the Ottawa Regional Innovation roundtable, you can be very proud of your role in pioneering the partnerships behind many achievements. I can tell you as one that comes from the Niagara area where in the early 1990s, we had 20,000 layoffs and 16 per cent unemployment, we used your process to help us to get out from where we were. Unemployment in the Niagara area is now 6 per cent and we're 10,000 skilled people short, now that our small businesses are taking over.
- Your vision and example as innovation leaders of this community have played a vital role in the development of technology clusters – a trend that we are gathered here to discuss and to improve upon. Of all the international research and innovation trends, nothing is more exciting than the growing capacity of individual communities to take hold of the future and define their own destinies.
- That's a message that is slowly grabbing hold across our country. And you, the new City of Ottawa and OCRI, and other local institutions, the companies and entrepreneurs of the National Capital Region, were among

the first to recognize this opportunity and seize upon it. Now, I ask you to share it with people across the country. You are not merely helping to develop specific technology sectors or fields of research, or even communities. You are helping change the way we see ourselves as a country.

- Last night, the guest speaker Mike Lazaridis talked about creating 'a wise country'. Those words are very powerful and I would ask you to remember that during your deliberations today. Rather than a fragmented collection of competing economic interests, we are building a coordinated national effort to become more innovative. By linking your efforts to the national mandate, programs, networks and services of the NRC, the Communications Research Centre, Industry Canada and other federal organizations, you are not only supporting your local technology clusters, you are integrating this region with innovation resources across Canada. And I remind people that while there are many areas that have great universities where science, research and technology are going, Canada also has many areas that don't have those universities. Thus, we need to link up our technology sectors on a continuous basis to support success in those areas as well.
- Six years ago at the inaugural Roundtable, you identified a set of priority initiatives. In this spirit, these initiatives have since been providing the necessary leadership for the development of regional innovation in Canada. Again today, you have that opportunity to look into the future to choose the path that we must follow. At the same time, you have continued to build on an impressive record of achievement in technology-based businesses and collaboration to provide new models for Canadians from coast to coast. As I mentioned earlier, you have a process here that we're trying to replicate in many communities across the country.
- Today, as you can choose specific issues of emerging technology clusters, you will be forgiven if your discussions focus on technologies and new businesses sectors such as bio-photonics and advanced Internet. But I would ask you to also consider the generic nature of these issues, so as to consider strategies from a perspective that can be applied nationally. For myself, the top of the list is occupied by the need to be more aggressive in our efforts to integrate and support innovative small and medium-sized businesses, those small entrepreneurs that grow and then become larger industries. As most of you are aware, SMEs account for the vast majority of firms, jobs and economic growth in this country. Yet we tend to think of their growth as a byproduct of other strategies and investments.

- I think we can do better. There are various ways to make Canada a stronger and more innovative country, particularly through effective technology-based assistance to SMEs. For the last number of years, I have worked across this country understanding the growth of SMEs, the difficulties that they encounter, and the assistance that they need. In this regard, I believe that a strong position on the options for addressing this issue in the context of the technology clusters phenomenon would be a very useful output of this Roundtable.
- I would not want to bias your consideration of this issue, but it is no secret that I believe that NRC's Industrial Research Assistance Program (IRAP) constitutes one of the most important features of the Innovation Strategy – specifically for small and medium-sized enterprises. Although IRAP is a part of the National Research Council of Canada, it is a pan-Canadian success story and likely the best program of its kind in the world. It embraces many companies represented in this room, for example, as well as innovation leaders in communities from coast to coast that got their start from IRAP programs. It is definitely an asset to build upon, and your views as a forum and roundtable will be greatly appreciated. The IRAP program is working with SMEs across our country, and I've taken it upon myself to inform and talk with MPs and so forth about IRAP.
- I want to go a little further on that. The world that you're working within has to train and educate local, regional, provincial and federal politicians. Luckily, I've been on both sides, and understand it a little bit more, and I'm pleading for your help to educate these people on how the world is changing. I see it all the time. In fact, I see it daily where Members of Parliament are looking for assistance to understand some sectors because they don't come from those fields. I happen to come from the automobile industry – at one time I operated six plants in three countries, and I understood the automobile industry – if anyone wants to know anything about V6 engines, I think I can almost repeat the part numbers. But, unless you're in the field, you don't understand the auto industry. I'm teaching and training MPs from all parties, all the time. They want to learn and to understand.
- It's the same thing in the new technology. They need to know because they make decisions, and not being knowledgeable, they make poor decisions. In this regard and others, those of us in Parliament and the Government, will continue to draw upon your expertise as we work together on our shared goals of making Canada the most innovative country in the world.

- David Crane, economics editor of the Toronto Star, wrote a few months ago about 'social capital'. Economists and finance people are starting to learn more about it, but you have been harvesting it. Using the social capital of communities has been part of your success. I want to congratulate you on your work and your deliberations: it shows that competitors can work together as partners to take that leap forward at the lowest costs without wasting precious resources. And we all need to do that from all walks of life.
- So I want to thank you and wish you the best in your workshop today. I must leave to go to the Standing Committee of Industry, which is discussing the new competition law. But I will be back later to spend the rest of the day with you. Hopefully, I will continue to be a promoter of research and development for many years to come. I lived it, I understand it a bit, and I will promote the idea that Canada needs to not only double, but perhaps triple, the research dollars for our country. We've learned from our past mistakes. But let's not do it again. Please talk to your elected officials and train them to understand your business.
- Thank you very much!

Welcome by Co-Chairs

Dr. Arthur Carty

President, National Research Council Canada

Arthur Carty took office as President of the National Research Council of Canada (NRC) in July 1994. Since then, he has been promoting the vision of NRC as a leader in the development of an innovative, knowledge-based economy through science and technology. He is an active researcher in the field of chemistry and a former president of the Canadian Society for Chemistry. His research interests are in the areas of synthetic chemistry, metal clusters, polynuclear activation of small molecules, and new materials. He has published more than 250 papers in research journals, in addition to review articles and book chapters, and has chaired or served on many peer evaluation committees for NSERC and other organizations.

Dr. Carty is currently an associate member of the NSERC Council and a Member of the Board of the Mathematics of Information Technology and Complex Systems (MITACS) Network, one of the Networks of Centres of Excellence. Prior to his appointment at NRC, Dr. Carty spent 27 years at the University of Waterloo where he was successively Professor of Chemistry, Chair of the Chemistry Department, and Dean of Research. He spent two years as an assistant professor at Memorial University prior to joining Waterloo. Dr. Carty has served on many boards and councils and is currently a member of the Atomic Energy Control Board, the boards of the Communications Research Centre and of the Ottawa Centre for Research and Innovation, the Environment Canada R&D Advisory Board, the Department of National Defence R&D Advisory Board, the International Advisory Board for the APEC Center for Technology Foresight (Thailand), and the Interim Governing Council of the Canadian Institutes of Health Research.

Among the numerous honours he has received are the Alcan Award of the Chemical Institute of Canada, the E.W.R. Steacie Award of the Canadian Society for Chemistry, the Montreal Medal of the Chemical Institute of Canada, the Purvis Award of the Society of Chemical Industry, and the title of Officer of the Ordre National du Mérite in France. He is a Fellow of the Royal Society of Canada, an Honorary Fellow of the Chemical Institute of Canada and has honorary degrees from the Université de Rennes in France, Carleton University, the University of Waterloo, and Acadia University.

- I'd like to say an official welcome in the name of the National Research Council of Canada to all as participants in this Roundtable. Au nom du Conseil national de recherches du Canada, permettez-moi de vous souhaiter la bienvenue à cette septième Table ronde du Forum régional de l'innovation. Well how time flies. As you know, we launched this initiative in 1996 with the idea of promoting innovation and removing barriers to innovation in the Ottawa-Carleton region. Today, wherever you look, wherever you turn a page, there is talk of innovation. In fact, I think it would have been great for NRC to have patented or taken a copyright out on the words 'Technology Cluster of Innovation' back in 1996 – we might have been doing a little bit better.
- I think we can take great pride in the fact that the forum and the roundtable have played a key role in raising the importance of community innovation in particular. This is now one of Canada's major economic growth strategies. Coupled with the approaches that we've adopted to skills development, again pioneered through the Vitesse Program, there is evidence enough that these Roundtable activities continue to generate new ideas and provide effective solutions.

- At this time, as Roundtable Co-Chair, it's normal for me to provide a report card on the discussions and recommendations that have taken place since last year's Roundtable. We have had three forum meetings since that time. Those of you who attended this event last year will remember that participants expressed a need to have the final report from this Roundtable produced much more quickly than traditionally was the case. We've managed to do that – the Regional Innovation Centre was able to produce the completed report in approximately four months following the Roundtable. It's a difficult process, but we're going to strive to improve that deadline this year. We also want to ensure that all participants have access to the deliberations summaries quickly enough for action to be taken before the next year's events come along.
- From discussion emanating from the Roundtable last year, we had identified two important priorities and from those two priorities came some recommendations. One of those was to tackle the skills issue as it related to strategic marketing. Last year's Roundtable was about marketing and improving the awareness and recognition of strategic marketing research as a key ingredient in product commercialization. So with respect to the skills issued for strategic marketing research, I'm very pleased to report on two new developments. The first recommendation was to launch a Vitesse-type strategic program for marketing, and the new Vitesse Re-Skilling program will be put in place this fall. Initial modules of curriculum and content have already been developed and testing of the program will take place with clients in the next few weeks. In addition to that, Carleton University has implemented a program that focuses on the strategic marketing needs of the technology sector. In addition, a Regional Innovation Forum working group was tasked with re-defining the guidelines for SR & ED tax credits. This group is examining the possibility of including some marketing research experience as a defined element of scientific research. This reflects the idea that marketing research is an essential requirement for product commercialization and testing.
- The second key recommendation was the creation of a think tank in the region to develop a mechanism for providing timely new information on other economic growth opportunities, which could be made available to city planners. Three groups were formed at the Forum to provide suggestions on how to deal with this particular issue and after discussions, it was recommended that the ideas of all three groups be synthesized into

a single proposal. This exercise is currently being completed and we'll be examining ways of tying into the City of Ottawa's desire to create a listening post on new technology developments. The City would like to see this initiative led by the private sector and we are very hopeful that's the way it will develop. Of course, I think we all recognize that it's quite difficult for city planners to deal with situations such as an unprecedented downturn or even an upturn in the economy.

- As you can see, the Regional Innovation Forum continues to work hard to foster a technology-based entrepreneurial culture and to remove barriers to innovation and growth in the region. In effect, the Roundtables held to date have been idea incubators. The report card this year is evidence that they are part of an ongoing process that continues throughout the year, such that actions can be taken on the ideas and contributions emerging from the conferences.
- Now, I think it might be useful for those of you that haven't been to all of these events to take a look at how the major themes of previous Roundtables have evolved. Perhaps you can also keep in mind what has actually occurred in this region over the last six years. You can see that we've taken a number of different approaches over the six years, starting off with this initiative in 1996 to look at Ottawa-Carleton as a techno-entrepreneurial region and to examine the barriers to innovation. We've examined sectors, integration, and various new possibilities.
 - Roundtable I (1996) dealt with the development of a techno-entrepreneurial region;
 - Roundtable II (1997) highlighted the potential for growth of the telecommunications and photonics sectors in the region;
 - Roundtable III (1998) underlined the connection between life sciences, information technology and telecommunications clusters;
 - In 1999, we decided to stress the importance of the service sector in the growth of the region, with a focus on financing;
 - In 2000, at the fifth Roundtable, the need to promote innovation within Canadian enterprises was the main thrust of the discussion;

- Last year, we focused on the importance of strategic marketing, a key element of success in a technological environment. And, as I noted earlier, a number of actions have been taken in this area.
 - And, finally this year – with the need to identify new opportunities in mind – we chose to highlight emerging technology clusters.
- Today, we'll be looking at new opportunities on the horizon such as new technologies that emerge and mature towards commercialization. Technologies such as bioinformatics, genomics, and nanotechnology offer significant new opportunities and challenges. They perhaps represent the next wave of technological advances that are likely to impact regional economic growth in a considerable way. But let's not forget that new breakthroughs and applications of science often seem to emerge from nowhere. It's indeed very difficult to predict the future.
 - Our speakers today will outline some of the potential economic impacts. Ottawa, with its telecommunications and information technology sector strength, coupled with emerging activities in the life science sector, is perhaps better positioned than most other regions to take advantage of the commercial opportunities arising from bioinformatics and genomics.
 - Over the course of today's sessions, you will not only learn of the developments in these technological fields but also, study, analyse and potentially develop new opportunities for the region. Let me just give you one indication: Lon Guertin, outgoing CEO of IBM, said the following in the hot-off-the-press 2001 Annual Report:

I want to use this occasion to offer a perspective on what lies ahead for our industry. To many observers today, its future is unclear, following perhaps the worst year in its history. A lot of people chalk that up to the recession and the 'dot.com bubble'. They seem to believe that when the economies of the world recover, life in the information technology industry will get back to normal. In my view, nothing could be further from the truth.

- So one of our goals today is to take a peek at some concepts and developments that we may not have thought of as drivers in the future. We will be asking how we can use these leading-edge technological advances and continue to put science to work for this region and for Canada.
- If the discussions here inspire action, which in turn leads to new activity in the region, we will have been successful. If it leads to greater awareness,

which later leads to greater investment of time and resources in these areas, we will have been successful. If it leads to further discussions on these areas of activity, we will have been successful.

- We'll certainly follow up as we have promised in the past. We'll follow up from the recommendations of this Roundtable. So, I would like to invite all of you to participate fully at the Roundtable and to benefit from the points of views expressed by what we think is a strong group of speakers and panelists. I should also get a plug in for the fact that at lunch time, I will be launching NRC's Vision for 2006 and I hope that this will illustrate how NRC intends to put its research and technological capabilities to work with communities to foster regional and local innovation to sustain those technology clusters, which are so vital to a knowledge-based economy in Canada.
- Je vous souhaite des discussions fructueuses. Merci beaucoup. Thank you.

Kirk Mandy

Vice-Chair, Zarlink Semiconductor

Kirk Mandy has been involved in the data communications and telecommunications industries for more than 22 years. He has held senior management positions in manufacturing, product operations, and research and development. Kirk had been with Mitel Corporation for more than 15 years and was appointed to his current role as Vice-Chairman, Zarlink Semiconductor, in 2001. Kirk is also a member of the Nominating and Audit Committee and chair of the Compensation Committee.

For six years, Kirk served as Vice-President and General Manager of Mitel's Semiconductor division. During this period, he aggressively grew the business from a unit focused largely in-house to one of Canada's largest and most profitable merchant semiconductor operations. Mitel Semiconductor was recently renamed Zarlink Semiconductor and trades under the symbol ZL on the New York, Toronto and London stock exchanges. Kirk also served as Vice-President and General Manager of Mitel Communications Systems for several years until his appointment to President and CEO, a position he held from 1998 to 2001. The systems business provides converging voice and data network systems and applications to enterprises, and was recently sold to interests controlled by Dr. Terrence Matheus, the founder of Mitel and Newbridge Networks.

Kirk is a keen contributor to the growth and success of Canada's high tech community. He is a board member of the Strategic Microelectronics Corporation, the Canadian Advanced Technology Association and The Ottawa Partnership (TOP). He is also Vice-Chair of the National Research Council of Canada's Regional Innovation Forum. Kirk is a graduate of Algonquin College. He is married with five children and lives in the Ottawa area with his wife and family.

- Last year in the Forum and at the Roundtable, we placed a special emphasis on the need for strategic marketing expertise here in Ottawa and across Canada. As we've said before, I think we all continue to believe that this is an area of opportunity for most technology-oriented companies. Although this Roundtable, and others in the past, are about technology, it is not technology alone that generates wealth. It is business that generates wealth and business is about serving customer needs profitably. Understanding the needs of customers is paramount as we organize this Roundtable and present potential new opportunities from emerging technologies.
- The fundamental question of understanding customer needs is key to continued success. In understanding these needs it's important to identify where the money is, who the decision-makers are, what's important to the customer, and who else knows this information. Understanding this is strategic marketing. Strategic marketing is not going to trade shows; it's not about developing collateral. Strategic marketing is about understanding intimately a customer segment from a business perspective. It's about developing and verifying a compelling value proposition and about managing competitive advantage.
- Some of the key questions to ask if one is aiming to win in a highly competitive market place are: Do I really understand my customer? Am I dealing with the decision-makers? Who else knows what I know? And how do I maintain competitive advantage. Am I prepared to do whatever is necessary to win?

- Today, we'll be discussing emerging technology clusters. These emerging technologies provide new opportunities, but unless these opportunities are linked to the needs of the customers, they cannot yield wealth. It's with this in mind that we've decided to stress strategic marketing. We are pleased to develop a new Vitesse-like program for strategic marketing that will ensure Ottawa – and hopefully Canada – has the skills necessary to take technologies to a sustainable level of growth.
- As Co-Chair of the Forum, I would like to echo Dr. Carty's welcoming remarks and encourage you to fully participate in the Roundtable discussions. We hope you enjoy the Roundtable discussion activities and thank you very much for your attendance and participation.

Key Note Presentation

Our Molecular Future: How Nanotechnology, Robotics, Genetics and Artificial Intelligence Will Transform our World

Douglas Mulhall

Author

*Douglas Mulhall describes how genetics, robotics, artificial intelligence, and nanotechnology may revolutionize our capacities to tolerate climate changes or natural disasters. His new book, **Our Molecular Future**, depicts disciplines such as nanotechnology where nanotechnology interacts with ecology; and discoveries such as nanobacteria, that may transform health care. His interdisciplinary experience comes from managing European and Latin American scientific institutes that pioneered Life Cycle Assessment-based products along with water recycling, flood control, and integrated agriculture, in collaboration with the European Commission, research laboratories, and multinational chemicals companies. His work is published by Financial Times (London), Die Zeit and Frankfurter Allgemeine Zeitung (Germany), and Globo (Brazil), as well as in Nanotechnology Magazine, The Futurist, Water Environment & Technology, and Futures Research Quarterly (U.S.) With a background in communications, he earlier co-founded an international television network and produced award-winning documentaries. For information on his analysis of adaptive technologies, see: www.ourmolecularfuture.com*

INTRODUCTION

What Alvin Toffler's *Future Shock* was to the 20th Century, *Our Molecular Future* may be to the 21st. Douglas Mulhall describes the exponential changes that are about to be brought by the nanotechnology and robotic revolutions. These promise to reduce the scale of computing to the nanometer, a billionth of a meter. While increasing computing power to almost unimaginable levels, the resulting convergence of genetics, robotics and artificial intelligence may give us hitherto undreamed-of capacities to transform our environment and ourselves. We may see a new world with cars and cloths that change colour on a whim. Machines that scour our arteries to prevent heart disease and exotic new products built in our own desktop factories.

But while these technologies are beginning to converge, we may also encounter surprises that throw us into disarray. Climate changes, earthquakes or a seemingly improbable asteroid collision – these extremes are not the nightmare scenarios of sensationalists, Mulhall stresses, but instead are part of nature's cycle. The good news is that this collision of catastrophe and technological transformation may work to our advantage. If we are smart, we will use the new molecular machines to build innovative industries that protect us from nature's potential calamities. Mulhall's visionary link between future technologies and past disasters is a valuable guide for everyone who wants to be prepared for the 21st Century.

- Good morning. Today I am going to talk about impossibilities that may soon be realities and to help us suspend belief I would like to mention a few examples that have occurred in the past of the same order.
- In the 1930s, a young scientist wrote to the journal *Nature* about the possibility of existence of a class of sub-atomic particles. The editors wrote

back that the existence of such particles was pretty well impossible and that readers would probably not be interested. The scientist was Enrico Fermi and the particles were neutrinos, which today are acknowledged as being among the most plentiful substances in the universe. A few short years later, Fermi went on to develop the first nuclear chain reaction.

- When we talk about the impossible in technology, we have to be careful. Just as the builder of this hotel [the Château Laurier] learned when he crossed part of the Atlantic in the unsinkable Titanic. Moreover, such impossibilities aren't limited to the last century. In 2001, the City of New York spent many millions of dollars to build its high tech Emergency Response Command Post in what it thought was the most impregnable place to be in case of a disaster – the World Trade Center.
- I hope that these examples help us to suspend our judgement about the impossible, because what I'm going to talk about today is just that. I would like to start with a few definitions, just so that we are on the same page. When I say molecular technologies I'm referring to the group that I call the GRAIN technologies: genetics, robotics, artificial intelligence and nanotechnologies. It is the convergence of these technologies that is going to bring the big changes, not the individual technologies by themselves.
- Now when I talk about nanotechnology, it is important to differentiate between nanoscale technologies and molecular nanotechnology. One represents the present while the other one presents a new kind of future that many of us still think is science fiction. Most of us here know that the nanoscale technology is technology that is used to manipulate matter at a scale of one billionth of a metre. On the other hand, the Drexlerian definition of molecular nanotechnology adds a few criteria, these include self-replication where molecular-scale machines manufacture copies of themselves, and assembly where molecular-sized machines assemble parts into other machines. So these are the three aspects of Drexlerian molecular nanotechnology.
- Nature has done this for millions of years using DNA as software to replicate cells, then assemble them into complex structures. Yet so far, we have only managed to do this in very primitive ways. Just a few years ago, most scientists thought that molecular assembly was impossible. Nobel prize winner Richard Smalley, who discovered carbon nanotubes along with his

team, has detailed the skeptics' position in a Scientific American article. But after new discoveries only last year, we see that molecular assembly may be practicable. In 2001, scientists at the National Institute for Materials Science in Japan created nanoscale materials that spontaneously form into groups of wires, for example.

- So how close are we? When considering how far off molecular assembly may be, I refer to the computer pioneer, John Van Neumann who said in 1949, "it would appear that we have reached the limits of what it is possible to achieve with computer technology, although one should be careful with such statements, as they tend to sound pretty silly in five years."
- In 1997, some scientists were being chastised for telling us that the human genome might be decoded by 2005 or 2010. Of course, now we've reached that goal. Despite the apparent impossibilities, molecular assembly is becoming central to every discussion about bringing new technology to the marketplace. If we teach machines to assemble themselves, assembly lines may be built at a scale that we are unable to see with the naked eye. They may eventually have their own abilities to extract raw materials, convert them into parts, and assemble those parts into machines such as cell phones, televisions and computers. If molecular assembly proceeds at the same pace as decoding of the human genome, we may see a radically different situation in the near – rather than the far – future.
- For example, last week I watched a program on the Discovery Channel, entitled "How it's made". This explains high tech processes for manufacturing textiles, bicycles, safety glasses and nails. Each of the methods depicted in this show may be eliminated by molecular assembly. The furnaces, presses, bobbins, lathes, looms, cutters, molds, cleaners and assembly lines would be replaced by self assembling software-driven, molecular-sized machines that build things atom by atom.
- The job that I've been given today involves reconciling the present nanoscale technologies with the more uncertain Drexlerian future. This is a schizophrenic task. On one hand, I have to look at what type of applications might be just around the corner for companies that are preoccupied with surviving until next Wednesday. And on the other hand, talk about a future that within the next few years could see our industrial infrastructure replaced by molecular machines, so you'll have to forgive

me as I pop back and forth between the enabling tools that you are working with today and the resulting technologies that may make your technologies seem like stone axes only a few years from now.

- The good news is that we are on the edge of a future that is so fantastic it's unbelievable. The bad news is that no one believes it and we're not getting ready to cope with it as a result. When I started to write my book about this, I got up after the first page and went to the beach, for a few weeks actually, because I couldn't find a way around this dilemma of how to make an unbelievable future believable. Fortunately, after some weeks of surfing and surfing the web, I discovered that I was not alone and that a number of respected scientists found themselves in the same position and this dilemma has a name. It is called singularity.
- Singularity is the point at which technology converges at such a rapid pace that the future becomes unknowable. Among the notables who try to describe this indescribable singularity are the head of Carnegie Mellon's Robotic Institute, along with the inventor of genetic computing and other respected scientists. These are serious players with a serious message. Just when we'll see singularity really no one knows: some say 30 years, other say 50 and the skeptics say never. But what I've seen in my research is that it is a good bet that we're about to enter a world where, for example, we have robots that are smart enough to soothe our emotions and do our accounting, other robots with immense computing capacity that makes them conscience of their own existence, and humans who are artificially enhanced by computers, robotics and genetics.
- Some scientists call this a post-human era, but I like to call it the advanced human era because it may include the very best of what we are as a species. The key to this future is something that managers like to call variety. When we use this term, they are describing the complexity of the environment compared to the complexity of the methods required to cope with that environment. The underlying principle is that the more sophisticated the management environment, the more sophisticated the management response has to be to adapt to that environment. Many of our technologies are unable to match the complexity of natural environments. For example, we use antibiotics to cure bacterial infections, but they lose their potency when the environment that they work in adapts to them. We build power lines to survive ice storms, as we know here, but our miscalculation of the worst scenarios leads to collapses that paralyze our high technology infrastructures.

- These are examples of how our technologies and methods are still too primitive to cope with nature's complexity. In fact, most of our agricultural, medical, energy, transportation and housing systems are in a constant struggle to respond to the relative complexity of the natural environment. Yet probably in the span of our lifetimes, this imbalance is going to change. Molecular technologies may empower us to find solutions that match nature's complexity. Our energy grids may be safe from disruption; our drugs may be so precise that they backfire only occasionally instead of generating widespread immune responses. Moreover, molecular technologies may slash the costs of doing these things, which will bring these advantages to billions of people.
- But at the same time, we may not understand how the artificially intelligent machines that we create actually solve these challenges that we have given them. And if we think that this is so far into the future consider this: last year, a computer that uses something known as genetic computing built a thermostat and an actuator that were superior to the counterparts designed by a human. The computer programmers were unable to trace how the computer reached its conclusion. This is because genetic algorithms allow computers to solve problems in their own way. The leap from there to robots with consciousness is not far – though probably not as close as the next few years.
- So where does this leave us Homo sapiens? Right now, it leaves us with some choices about how we would like that intelligence to develop, but I would say we don't have too long to figure it out because the rate of increase in computing power (shows chart). This might be a little bit difficult to see but basically you are looking at a logarithmic scale on the left hand side that shows the rate of development of MIPS in computing. At the upper right hand part of that scale, given the various states of development starting from 1995, 1997 and onwards, we look at this scale and see that sometime in the next 20 to 30 years, we are going to reach computing that has the same memory capacity as a human being. It becomes apparent that one of the challenges faced by those of us here is to think the unthinkable – that we may be superseding ourselves as the dominant species on this earth. And when we see that, we also realize that as an earlier step, we may soon co-exist with semi-intelligent machines as companions. If we want a taste of this, we just need to look at the personalized robotic companions that have come on the market last year.

- The example of Sony's AIBO robotic pets is a case in point. Since its introduction last year, the AIBO line has been astoundingly successful. The depth of AIBO's popularity was shown when rogue programmers started publishing programs on the Internet that allowed AIBO to develop new personality traits such as dancing and singing. Sony then tried to force the rogue sites to close down – only to be surprised by the wrath of AIBO owners who threatened to boycott Sony products. But in a deft marketing move, Sony then introduced a new singing, dancing humanoid robot some weeks ago, thereby end-running the hackers at their own game. AIBO and its offspring have shown, without a doubt, that we are ready to embrace personalized robotic companions. It is the first indicator that such companions may gain widespread acceptance in society.

- For the people in this room, this means that the day is fast approaching when the machines that I call roboservers begin to work as companions for the sick and elderly. Some may see this as a bad thing, but I don't. I believe that robotic companionship and health care may be one of the great growth industries of this decade, especially as GRAIN technologies continue to converge and robotic companions improve their own capacities to learn. These are some of the more profound implications of the convergence of GRAIN technologies and the development of molecular nanotechnology. Nor are they necessarily bad, in fact they may be the best things that happens to us. Because our own creations may guide us into an enlightened future if we imbue them with the right traits.

- But a lot of religious institutions and environmentalists have seen this future and said, "I'm not so sure I'm going to like this." Some organizations have gone on the warpath and their influence has reached as far as the White House. Here's a quote from last week's New York Times regarding a new book that has just been published by one of the top biotechnology advisors to President Bush. "The most serious threat to the stability of human societies is genetic engineering that may alter, by design or inadvertence, the special balance of contrarities of human nature." Human nature, Dr. Fukuyama the author argues, is fundamental to our notions of justice, morality, and the good life. By messing with the human genome in order to enhance intelligence or physique or other desirable qualities, biotechnology may cause us to lose our humanity. This is not a cleric speaking: this is a Harvard University political science professor.

- The political mainstream is worried that if we look at Dr. Fukuyama's arguments alongside those of religious and environmental opponents of genomics, then we see that, as the adage goes, "Houston we have a problem." The problem is that we may be bouncing off the future before we get to it. Most of us think that the attitudes that forced Galileo to recant his discoveries are a thing of the past or reserved for the Taliban. And yet we see signs that influential groups are getting uneasy with what science seems to be embarking on. We have to remember that science has only won the public trust in the last 100 years and that this is a privilege that had to be fought for. For these reasons, I believe that if we want to move forward into this incredible future – or at least have a reasonable shot at doing it – we have to adopt an overarching set of principles to maintain that public trust and support. The question is where do we start and what does it mean for those of us represented in this room today.
- Principally, I think we have to adopt a doctrine of mass survival. That is to explicitly say that we are not going to leave most of society behind as we are embarking upon this journey. Instead as a priority, we are going to use the power of this technological convergence to bring measurable benefits to each and every individual. This is not socialism or any other type of 'ism' because the very basis of molecular technologies may allow us to achieve this without resorting to any political 'isms'. The notable strength of molecular technologies are their ability, as I explained earlier, to adapt to greater complexity by responding with equal complexity. For the first time in our history, this may give the individual the ability to meet his/her own needs individually. So although we are committed to mass survival, we may be able to do it in ways that meet the needs of each individual.
- Here are some examples of how we might implement the doctrine of mass survival to instill public confidence in these powerful technologies. I selected these examples with a view to showing how the technology clusters represented in this room might benefit from such applications. I've already mentioned robotic companions. The significance of AIBO the robotic dog is not to be underestimated. This already involves the convergence of massive computing, artificial intelligence, robotics and nanotechnology and may soon include genetics, because DNA replication may be one way to achieve biologically based computing, especially given that the first DNA motor was invented just last year or the year before.

- Yet, we only have to look at the cost of AIDS drugs or real time video conferencing to see that affordability affects wide-scale adoption. Fortunately, the molecular revolution is helping us to make things available more cheaply, more quickly. A prime example of this is digital fabrication. This model of a skull was printed on Z Corporation's 3D printer. The printer uses an ink-jet print head to deposit binder and glue parts together layer by layer. By gathering data from scans of the human body, such objects can be manufactured to precisely replicate the bone structure of a patient. This lets physicians plan their work without invasive exploratory surgery. It's fast and it's cheap. The machine that makes it costs about the same as a high volume photocopier and a model like this can be made in just a few hours.
- I believe that digital fabrication is going to be one of the great consumer revolutions of the next few years. Just as ink-jet printers now allow us to print our documents at home, ink-jet fabbers are already being used to build customized three-dimensional products. Once we move this type of manufacturing out of the factory and into the home – as is happening right now – this may have dramatic impacts on the whole consumer products industry. Just as the individual is now free to produce their own publications at home or on the Internet, consumers may soon be able to customize their own products in the same way. We can bet that technologies such as photonics that are being developed here in Ottawa have a big role to play in imaging and pushing data down broadband pipes to support the Internet-based software that manufactures these products.
- To see where we might get health benefits on a very large scale, let's look at what's driving the globalized consumer economy. At the end of the Cold War as markets matured in the industrialized nations, the markets of developing nations grew attractive to multinationals. Yet, there was and still is a big problem. For consumers to consume, they have to have a disposable income. To have a disposable income, they need to have higher paying jobs and to work at higher paying jobs, they have to be healthy. Yet for most of the population who live in tropical regions, disease impinges upon their ability to generate wealth. Many such diseases are classified as orphan diseases – diseases that haven't been adopted by rich nations as priorities to solve.
- Among the worst of these orphan diseases is malaria. More than one million die annually from it and tens of millions are sickened for life. Many are children and the numbers are staggering. A salient characteristic of malaria

is that those who have the problem don't have the money, and those who have the money and temperate climates, don't have the problem – unless of course you happen to be an unfortunate tourist. The other characteristic is that the parasite that causes malaria is extremely complex and our response to it has been extremely primitive. The common prophylactics are to toxify the liver so the parasite cannot take hold or toxify the environment with DDT and each of these leads to long-term problems.

- The prerequisites to finding a cure are political will, money and innovation. On the political and financial front, companies now understand that to transform malaria victims into consumers, the Cold War policies of benign neglect won't work. In 2001, a private donor gave \$100 million to Johns Hopkins University to develop a malaria vaccine. At the same time, the National Institute of Allergy and Infectious Diseases announced a global health plan to attack HIV/AIDS, malaria and tuberculosis. The Institute's director, Anthony Fauci, gave a reeling rationale and I quote, "The issue of global health has now integrated itself into this nation's foreign policy." That has great significance for everyone in this room from a financing point of view.
- Thus, due to demands of the globalized market place, infectious diseases are now targets of American foreign policy. In 1999, trials began on a Glaxo Wellcome DNA vaccine that uses the molecular makeup of the body's own defenses. In late 2001, a team in Australia announced that they had found a way to infect whole populations of malaria carrying mosquitoes with genes that neutralize the parasite. A vaccine that wipes out parasites in the liver and prevents their spread is undergoing trials in Gambia.
- A prerequisite for these new approaches is modeling. Right now, our modeling seems sophisticated but actually it's quite primitive when it comes to forecasting environmental responses. Molecular computing is going to change that. With the invention of molecular-size logic circuits last year, we see a real possibility for mega-computing that is exponentially faster in packages that are thousands of times smaller. A precursor to this type of miniaturization can be seen, for example, with artificial retinas that have been transplanted into vision-impaired patients. These consist of computer chips that relay light signals to the optical nerve. As mega-computing improves, we are close to the day when artificial eyesight is commonplace.
- Mega-computing may also have dramatic effects in our ability to see non-invasively into the body. For example, technologies developed at the

University of North Carolina, University of Illinois, and here in Canada link computer graphics and virtual reality with images of the real world. This is known as augmented reality. Data are delivered by ultrasound that generates real time images from sound waves bouncing off tissues inside a patient. These are combined with the video image from a camera focused on the patient. The combined data are seen by the operator with a head-mounted display. For patients, this avoids the uncomfortable and expensive step of exploratory surgery and goes a long way towards eliminating unnecessary surgery. Moreover, such advantages for patients can be further enhanced through the use of gold 'nanoshells'. These are being investigated as a means of delivering accurate doses of drugs to define areas of the body. These may be cheaper, more efficient, and far less traumatic than the type of drug delivery that we have today.

- Each of the examples I've given here are being financed by the U.S. military and yet, they are also being used in medical, environmental and other research. It's no secret that the relationship between the military and technology companies has been strengthened here in Canada since September 11th. Yet, much of the military research being financed, for example, by the Defense Advanced Research Projects Agency (DARPA) in the U.S., has dual applications for health and environment.
- By exploiting these dual applications, Canada's researchers may be in a special position to help carry these applications into the civilian realm, thereby bringing broad benefits to the populations while creating new markets. In countries such as Canada, it pays to focus on a definable goal to avoid spreading your resources too thinly. A guiding principle that the National Institute for Nanotechnology might use is to focus on technologies that measurably enhance people's personal security. These methods may range from more accessible treatments for orphan diseases to robotic caregivers that cut the cost while increasing convenience of medical and other types of personal services. The first task is to ask the right questions about what might be the most effective enhancements to personal security. Then, look at how molecular technologies might help to make them real.
- I've touched on a few of these questions today. A more complete outline is discussed in my upcoming book, and here's my plug, called *Our Molecular Future* scheduled for publishing next month. Nanotechnology magazine is also devoting articles to this topic, and I'd like to thank its publishers

for their foresight in doing this. If we can implement at least some of these technologies to show broad benefits for each individual, then perhaps taxpayers may be more receptive to going along for the ride on this fantastic venture.

- Thank you very much.

QUESTION AND ANSWER PERIOD

GERRY TURCOTTE, COMMUNICATIONS RESEARCH CENTRE:
What is a DNA motor?

DOUGLAS MULHALL: It is an engine derived from the power of DNA self-replication.

FROM THE FLOOR: We're talking about regional economic growth, and I can see how all the advances for medical care would be wonderful for everybody. But nano-machines and self-assembling nails on an assembly line – that would cause a lot of job losses. How would you rationalize that as being a big boom for everybody?

DOUGLAS MULHALL: Actually, that's an excellent point and it's something that I write about. The definition of work is definitely going to have to change. When you have this massive displacement of all these industries, very suddenly government is going to have to play a major role in the transition. There is no question about this and I think that the Canadian government and the Ontario government are going to find themselves in the forefront of this as you have this logarithmic acceleration of these industries being displaced by molecular technologies. On the other hand, we've seen the tremendous ability of technology industries to spin-off, especially designer industries that are able to fit into these niches and employ a lot of people. But we definitely have to have a serious look at the employment implications. I think that organized labour and the Canadian government need to start right now to look at how molecular technologies are going to create new opportunities and require a total redefinition of work. And I'm not the first person to say this, Alvin Toffler said it in 1970 when he wrote *Future Shock*. We've gone some way to doing that, but as we've seen with institutionalized unemployment, we haven't been totally successful and I think that we've just gotten a small taste of what we're about to run into in the next 20 years.

FROM THE FLOOR: Doug, the ethical questions you talked about – the advisors of the White House – how can industry deal with the ethical questions? Should we deal with it straight up?

DOUGLAS MULHALL: I think that there are some good role models to go on. First of all, the National Institute of Health Guidelines on DNA and Genetics are very good and were developed many years ago. The Foresight Institute has developed guidelines for the development of molecular nano-technology and I would really urge people to go to their website and have a look at it (www.foresight.org). There are a few other organizations that are developing ethical guidelines for the development of these technologies. Isaac Asimov's Laws of Robotics, which were developed as part of his science fiction writing many years ago, bear serious scrutiny. These are just some examples of the ethical guidelines that are being developed, and there is no doubt in my mind that they are going to play a very major role in science's ability to continue with these technologies.

And it's something that nanotechnologists are beginning to struggle with right now. It's come up quite extensively at the Foresight Institute's annual meetings in the last two years, but the discussion is just beginning. I don't know if anyone saw, but a year ago, a coalition of organizations took out five full page ads in the New York Times, basically criticizing the whole approach to what they called 'Technologism', and this is a coalition of major environmental organizations and also a lot of scientific organizations. So there is a real debate going on now, and I think it is very important for people to get involved in it.

FROM THE FLOOR: We're in an age of security. Can you share with us some more insights of your thinking about the link between nanotechnology, molecular technology and the evolution of security technologies?

DOUGLAS MULHALL: One example that I like to give in terms of security is that "911" taught us a lot of lessons. And one of the lessons it taught us is that the impossible does happen and there are ways that we can prepare for this. For example if you look at the rate of production of carbon nanotubes these days, you see that 18 months ago, almost everyone was saying that large-scale manufacturing of carbon nanotubes was going to be impossible. Then Mitsui announced in the fall that they are building a plant to manufacture 120 tons of the stuff every year.

That's how fast this is developing. The reason I mentioned carbon nanotubes is because they could be extremely important for molecular computing and for structural strength. As probably most of you know here, carbon nanotubes can produce wires that have up to 30 times more tensile strength than steel, with the result that you can really build super strong structures – structures that certainly would not have collapsed for example, when these jets ran into the World Trade Center. So, in terms of enhancing personal security, I think that using carbon nano tubes for structural strength is a real possibility and a reachable possibility in the mid-term future and in the nearer term future.

I think that mega-computing is going to allow us to have smarter buildings that can actually defend themselves against these types of attacks. I think that we're going to be able to have broadly based collision avoidance systems where jet airplanes can actually talk to large buildings and initiate collision avoidance procedures. I have to differentiate between doing that and having someone take over remote control from the ground. That's been suggested and it simply won't work because a terrorist could do the same thing.

But artificially intelligent collision avoidance systems are a definite possibility. So, from the point of view of what we've seen with the World Trade Center, the lessons are: don't say anything is impossible. The solutions are definitely there with nanotechnology.

Key Note Presentation

Innovation, Convergence and Emerging Technologies

Dr. Alan Bernstein, PhD, FRSC
President, Canadian Institutes of Health Research

Dr. Alan Bernstein is known internationally both as a researcher and as a scientific leader. His pioneering research in the area of cancer, hematopoiesis and gene therapy remain landmarks in their field. Dr. Bernstein received his Ph.D. in Medical Biophysics at the University of Toronto in 1972. Following postdoctoral work at the Imperial Cancer Research Fund Laboratories in London (UK), he joined the Ontario Cancer Institute and the University of Toronto in 1974. He has been a Professor of Molecular and Medical Genetics since 1984. In 1985, Dr. Bernstein moved to Mount Sinai Hospital as Head of Molecular and Developmental Biology of its Samuel Lunenfeld Research Institute. He became Associate Director in 1988 and Director in 1994, a position he held until June, 2000 when he was appointed the inaugural President of the Canadian Institutes of Health Research.

His work has also been important in advancing techniques for gene therapy and the genetic analysis of mammalian development. As a scientific leader, Dr. Bernstein was highly successful in building and nurturing the Lunenfeld Institute into one of Canada's premier health research institutes. He understands Canada's health research climate and has been a valued consultant for many agencies and organizations provincially, nationally and internationally. From 1994 to 2000, he was a member of the editorial scientific review board for Science magazine. Dr. Bernstein held the first Anne Tanenbaum Chair in Molecular and Developmental Biology at the Lunenfeld from 1990-2000, the Koffler Chair for the Director of the Lunenfeld (1994-2000), and has received numerous awards and honours for his work, including the Genetics Society of Canada Award of Excellence, the Robert L. Noble Award from the National Cancer Institute of Canada, the Royal Society of Canada's McLaughlin Medal, the 2000 Henry Friesen Award sponsored by the Canadian Society for Clinical Investigation and the Royal College of Physicians and Surgeons, and the 2001 Medal from the Australian Society for Medical Research.

- I'm very pleased to have been given this opportunity to speak to you this morning. When I woke up this morning, I was listening to the live commentary on the Queen Mother's funeral. I couldn't help but think both about my talk and that funeral. And about what the world looked like when the Queen Mother was born, 101 years ago. It was a different world.
- I'm not going to list all the differences, but let me highlight a couple just to make a point. One is from a point of view of a geneticist: Mendel's Laws of Genetics had yet to be rediscovered, so we really – as a culture and as a society – knew nothing about genetics. One hundred years later, we have the complete sequence of the human genome. Insulin, which was discovered here in Canada by Banting and Best, was still 21 years away from discovery. Therefore the discovery of the chemical messengers we call hormones was still a generation away. Antibiotics had been discovered in the 1800s, but really not put to any use, not appreciated in terms of their public health value. In a very real sense, they too remained unknown.
- What has happened, of course, in the last hundred years has been a gradual acceleration. This is what someone once referred to as a hockey stick curve, where nothing much happens – at least on a log scale – for a long time and then all of a sudden it accelerates. Suddenly, the log looks like a hockey stick. I believe that we are in the early stages of a very, very profound

revolution in science. It really is a golden age of science. It's an age that is characterized by convergence, an age that is characterized by speed, and here in Canada, we have a big challenge, an exciting challenge, but a big one ahead of us. I think to get on this train and to be driving this train, it's going to require our image of our country to be one of innovation. The image of Canada, at the moment, is that we go canoeing at 9:00, come back and light a fire, and eat by the fire. It's kind of an image that we relish as a country actually: you know the picture of Trudeau canoeing in solitude is one that I think is on all our brains. The reality of course is that we can't wait till spring and summer, so we can have a cappuccino at the Byward Market.

- So, there is a disconnect between our image and reality, and I think that matters in terms of what we do – our national policies, our national programs. So what I'd like to do this morning is share with you my own vision of where things are going. Marshall McLuhan, a great Canadian futurist once said that predicting the future is passé, he also had a sense of humour. I'm not sure what he meant, but my interpretation of that is I think we are not good as a society in predicting the consequences of new technology. We think we can, but we can't.
- Let me give you two examples to illustrate how strikingly poor we are at doing that. When the automobile was first invented, in the early days of the last century, nobody worried about pollution, car accidents, noise pollution, etc., or about depleting natural resources and global warming due to burning carbon-based fuels. What people worried about was going at these great speeds of 30 miles an hour: they thought our internal organs would crush each other against our rib cage. That really was the concern of the invention of the automobile.
- When television came along after the Second World War, a major concern – I can still remember my mother yelling at me to move back from the TV – was the x-rays from the cathode tube. Nobody worried about the consequences of this new technology on young minds and the junk programming that's on most of television. So, we have a long win accurately predicting the consequences of new technology. If society is really going to embrace this future, there are major concerns. As a species, we worry about change per se, but we also worry about the real consequences of change on the economy, and about ethical issues around genetic privacy etc. We need, as a community both in academia and in industry, to be able to accurately

predict the consequences of new technologies if they are going to be accepted and indeed welcomed by our society.

- Let me look forward by looking backward, just to give you a sense of where we've come from and how quickly we're going to go forward. I won't go back to the 1900s when the Queen Mother was born, but let's start at the 1940s. We've just then appreciated that DNA was the genetic material. Two key experiments, one done by a Canadian group based at the Rockefeller – that was Adrian McLeod McCarthy – and the Hershey-Chase experiment, showing that DNA was indeed the genetic material. And, of course, the famous experiments of Watson and Crick in Cambridge showing that DNA was a double helix. The double helical structure became an icon of our time, but I don't think it was the important thing about that paper. The important thing about that paper was the discovery of complementary-based pairing and that self-replication was inherent in complementary-based pairing. Whenever there's a G, you know there's going to be a C; wherever there's an A, you know there's going to be a T. And so, you can unwind that double helix of DNA: the software is built into a molecule itself.
- We're going to accelerate here to the 1970s and the recombinant DNA technology of Boyer and Cohen in California. In the 1980s we come across the ability to develop highly complex genome libraries, the convergence of the human physical and genetic maps, the chain reaction, etc. Then we arrive at about a year ago, with the rough draft of the human genome and other model organisms' sequences. This is the beginning of a convergence between the traditional life sciences and informatics. The human genome has a vast amount of information – we are complex machines. Analysing that information requires computers and computational methodology and information technology.
- About ten years ago, we started to see the merging of biology and information technology. And of course, what a great opportunity for this region, given the IT industry and universities here with the life sciences sector, including the Ottawa Life Sciences Council, to really lead in this convergence revolution.
- That's going to have huge impacts on medicine (not medicare) and health. The health care sector is Canada's largest knowledge-based sector – both by size and by importance. What a fabulous opportunity is not around the corner, but is here to jump on that unbelievably important sector. I think

that the opportunities will only grow, as our population ages and as we move into a post-industrial society. What could possibly be more important than our health? There is a ready market for improvements in health and that's going to be driven by convergence of these very, very high-tech approaches to health.

- But we still are very much in the dark ages in medicine. Today most medicines treat symptoms. In fact, most health care systems treat symptoms. We don't understand schizophrenia, we don't really understand diabetes, we don't understand most serious diseases. Patients are therefore stratified and treated on the basis of clinical symptoms and the health care system is focused on treatment. An analogy I like to give is that it's as though your car didn't start and you took it to a mechanic and he said to you, "Well your car isn't starting." You know that! What actually matters is why your car isn't starting and there could be lots of reasons. If it's because of the battery, you replace the battery; if you're out of gas, you put some new gas in the tank; if it's the carburetor, you replace the carburetor.
- Those of you who are not in the health care sector, may not appreciate that we are still in the dark ages. At the moment, we can't diagnose what's wrong in most human diseases. And so we are treating the symptoms – the car not starting. That's going to change and there's an opportunity there and we are beginning to see the first evidence of that. In the future, medicine will increasingly target the underlying cause of disease. Patients will be stratified based on gene chip analysis – even the jargon is now converging. Treatment decisions will be based on both disease and pharma genomics. The health care system will be able to focus on prevention. Because we'll be able to predict, based on both genetics and lifestyle, who's going to get what disease and we'll act accordingly.
- Let me give you one example: cancer has gone – really in a generation since I started in cancer research to today – from being a complete black box to a much better understood disease. We had no idea why a cancer cell behaves differently from a normal cell. Yet we now understand the most intimate molecular details about what's altered in a cancer cell – at the genetic and the protein levels.
- And so now, the way to develop new drugs is not to throw poisons at a patient, but rather to target the disease in a very highly specific way that alters the matter in the cancer cell. And so, Narvaridis has developed a drug

Gleevek or STI5171 that targets the alterations in a family of proteins called pyrosencinasis, which are altered in many cancers. The two cancers against which Gleevek works most notably are in the product leukemia CML and gastrointestinal stromal tumours. What's striking there, of course, is that: a) Gleevek works, and b) it's not toxic. There are clear benefits, but it's also expensive. So there are, I think, three clear lessons there to health care policy managers. I believe that Gleevek is not a one-off but rather the first of a whole slew of new drugs that will be expensive, but that will work and that are not toxic because they target the alterations in disease. That has huge implications for society and for our health care system.

- I should say also that when the Queen Mother was born, the average life span of a Canadian was around 45 to 48 years. It's now about 80 years. We've almost doubled our lifespan in one century. Quite a profound change, which is largely not entirely the result of medical research mostly around infectious disease, but now increasingly around chronic diseases, heart disease, diabetes, etc. So looking forward, increasingly, and this is the theme of this conference, innovation research is going to be important to our country.
- This a quote from Juan Enrichis, Director of the Life Sciences Project at Harvard Business School: "A country's job, a government's task is to grow, develop and keep attracting talent and to make sure this talent creates and protects new knowledge. Nations and civilizations do not prosper or even survive if they cannot provide the fundamental pillar of a knowledge-based economy." That's as true, of course, in Canada as it is anywhere in the world including the United States. We need to attract and keep the very best young people in this country, people who want to do research and prosper, contributing to our growing knowledge-based economy.
- Computers and computational methodology have been essential for decoding the human genome. Conversely, the next generation of computing machines might indeed be DNA-based. Last year, a group in Israel published the first example of a DNA-based computer. This is a true example of convergence, where life sciences start using computers to understand DNA molecules, and computer methodologists and technologists are using DNA to develop the next generation of computers. We really are seeing convergence – we all need to understand both areas of science and technology. The silos are dropping because of this convergence. Convergence is creating its own opportunities and challenges. It requires critical mass; and critical mass not just in one area

obviously, but critical mass across a broad area. That is a particular problem for Canada. We are a small country in population, a huge country in geography. And so, creating clusters that generate critical mass is a particular challenge for us. We need to attract outstanding scientific talent, but we also need structures at the local and national levels that encourage and reward excellence in this transdisciplinary era.

- This is the front cover of *Nature* from about two months ago now, featuring an article from a group in Toronto about 'Functional Proteomics in Yeast'. Each of these ovals shown is a protein. Unquestionably Canada is a – if not the – world leader in proteomics and in understanding the lexicon, the rules of the game of protein/protein interactions, etc. That is so important in proteomics and this paper is just the latest example.
- This is the new way in this convergent world of looking at a yeast cell and soon a human cell. This is a diagram illustrating all of the networking protein/protein interactions in a yeast cell. This is work from MDS Proteomics that came out of work at my old Institute, the Lunenfeld in Toronto, and was sponsored by CIHR. This research reflects the partnership with MDS Proteomics and CIHR and we need more examples of that in this country.
- You have all heard that when the human genome was sequenced, that we only have 30 or 40,000 genes, not the 100,000 that people had thought about. That's true and it's not true. I'm not going to get into this in depth, but it's not just the number of units of information that's important, it's how they interact and the combinatorial numbers of interactions. Each of those lines represents an interaction between one protein in a yeast cell and another protein in a yeast cell. Let me just blow up a small portion of it. I think you can see there are huge combinatorial interactions within a yeast cell and I can tell you that the human cell takes one up an order of magnitude. So does the number of interactions within anyone of our cells, and we have thousands of different kinds of cells in a human body or in the order of hundreds and hundreds of thousands.
- We are very complex machines because we have a large number of units of information that can react with each other in very many possible ways. Those interactions are the targets now for drug discovery, and one reason MDS and other companies are so interested in proteomics is that these interactions are the key to the next generation of drugs. Perturbing those

interactions is where the action is in terms of new drug discoveries. Documenting those interactions, understanding them – not one protein interaction at a time, but across the whole cell – is key, if we are actually going to understand this beast of an individual cell and ultimately ourselves.

- I should say that that kind of diagram and that way of looking at proteins would have been unheard of five years ago. The technology for doing that – which is basically mass spectrometry – and the mathematics of doing that were not part of the life sciences lexicon. This has all happened in the last two or three years. I won't predict the future but you can extrapolate as well as I can that we don't know where this is going to go in the next few years.
- So let me talk then about convergence of disciplines. This is really a CIHR vision, not unique to us but certainly part of our gestalt now as we go forward. Information technology is obviously important. In addition, we can just keep rolling out those bubbles, if you will. Bioformatics came from almost nowhere to now being a real discipline. Molecular science is obviously an important part of the life sciences. We need to develop here in Canada a nanotechnology – a nanoscience that really brings together engineers, chemists, physicists, information technologists, health researchers to work on these problems. The opportunities are here for Canada, especially in genomics and proteomics. The social sciences are a key part of this as are the humanities and the traditional biological sciences. And let's not lose sight of the clinical sciences.
- All of these are coming together to create a new discipline of health research. There isn't a department of health research at a university anywhere in this country. There isn't a training program in health research that embraces all of that in this country. I'm not saying that as a criticism, but rather as one of the challenges we face in going forward, in terms of how we train young people. The next generation of health researchers needs to have both depth in one area, but they need to be more than just aware of those other nine areas. They need to have some degree of depth and understanding in all of those to really be able to contribute. This is a great opportunity, and a great challenge.
- When Parliament created CIHR almost exactly two years ago, the legislation talked about four pillars of research: biomedical and clinical science as well as health services and population health. It also talked about all disciplines that pertained to health. It's a very broad mandate, a very

exciting mandate. Our MPs need to understand that health research is changing and that this is a time of convergence where we need to bring people together under one roof in a unified way to address important and exciting problems in the science and research of health.

- We've responded, I think, pretty quickly in the last 18 months to the mandate given to us by Parliament. We have created 13 virtual institutes. They are shown deliberately as a jigsaw puzzle to emphasize this interlocking. And you'll see some traditional ones such as genetics and cancer research, and some non-traditional ones, such as aboriginal peoples' health, population and public health. Each of those institutes is lead by a scientific director. It's been fascinating for me to watch our 13 directors, who come from across Canada and represent very different disciplines, learn each other's languages. They've also had to gain trust and respect each other's academic cultures and in turn to disseminate that to the country at large. Research is changing in this country. We are really leading a profound revolution of convergence by bringing together people who, not only did they not talk to each, they didn't even know of each other's existence – sometimes even within the same university.
- I think it is a great opportunity for Canada again to be head of the curve given these new structures that Parliament has created and the new funding that's been given to us to stimulate this area of research. I'm not going to list all of the things that we have been doing, but here are some examples. In addition to other programs, we have established grants in the order of about \$300,000 to bring back stars to Canada. We have increased CIHR funding levels: the average grant has gone up by about 45 per cent in a year and a half. And we are building capacity across Canada. This is an important part of eliminating disparities, which is key if we are really going to bring the whole country along in this innovation agenda. We are about to announce a new form of training in an interdisciplinary way. It's a \$100-million investment over the next six years with industry partners, the provinces and health charities to train Canada's next generation of health researchers. This training initiative is transdisciplinary. It is a block grant to groups of investigators in multidisciplinary areas.
- In addition, we've published Canada's first integrated health research agenda; it is a book called *r: evolution – CIHR Towards a National Health Research Agenda*. It talks about four very broad areas at a very high level.

1. International leadership: Excellence is what this is all about.
 2. Interdisciplinary research: Bringing people from all disciplines together.
 3. Improving the health status of vulnerable populations, which includes everybody from children to people exposed to anthrax.
 4. Incorporating genomics and post-genomic technologies into our health care system and into how we think about health.
- In the past 2.5 years, our budget from Parliament has been doubled relative to the old Medical Research Council of Canada. That is one measure of how committed the Government of Canada is to CIHR, to health research, and to R&D in the broadest sense. We have been able to translate that into a huge increase in grant values.
 - It has been about two months since Industry Canada released its Innovation Paper. Obviously, health research is my CIHR-centric view of the universe at the centre of innovation. This is the century of health research. We are in a profound revolution in health research. Health matters more to people than anything else, nothing comes close. Innovation, therefore, has to touch on health and does and will. I think our role as an agency is central to pushing that innovation agenda. And I'm listing just a few of the things that we are and will be doing over the next few years.
 - So let me just end with some challenges that, I think, are for all of us in this room – in part because people are so important to the high tech sector:
 - How do we educate in this multi-disciplinary convergent world?
 - How do we transform our universities, because they are the vehicles for education to a large extent? And how do we transform traditionally discipline-based universities that rely on departmental faculty structures to move in some ways that translate those strengths into a new multi-disciplinary world?
 - These are tough challenges that are not challenges unique to Canada, but are arising around the world. As industry and government leaders, we need to work with universities to help them achieve this transformation.

- And here's another challenge to consider:
 - How do we develop new career paths in this multi-disciplinary environment and attract the very best young people into research?
- This is one of my major concerns. Young people are the future. If we want to get on this bandwagon, we have to make sure we are getting the best young people into research. One of my complaints always has been, if you are nominated for a Canadian award in English literature, you make the front pages of Canada's national newspapers. It's fabulous, it's a measure of how highly aware Canadians are of how good Canadian literature is. But if you win an international science prize, you are lucky if you are on page eight. We have got to change that around so that both are on page one and that we take great pride as a country in our very real national stars in medicine.
- About a week ago, *Nature* published the classic papers in stem cell research from the last 30 years. Stem cells, as you all know, is a very hot area. I did my own little head count last night. There are about 34 of these classic stem cell papers in the last 30 years, and almost half of them (16) are from Canadian labs. That is an astounding number. I gave the Minister of Health a little memo with that data yesterday. I think we should trumpet that to the heavens. Every other country would and so should we.
- The rapid pace of the scientific revolution is a challenge for scientists, but it's a huge challenge also for policy makers, MPs, and parliamentarians. Keeping pace with all of this, both at the scientific level and its implications for society, is a big challenge. I've already mentioned that creating critical mass is important and it's a big challenge for a country like Canada, as is scientific illiteracy and the flipside, scientific literacy. We need a literate population to move the people along in this innovation agenda. If they are not with us, they will be against us.
- And we need to deal with the disparities. The health and economic disparities are a big challenge and we need to have a public dialogue. There are many issues, particularly in the health area. Everything from genetic privacy and stem cells to embryo research, gene patents, pre-symptomatic medicine and being able to predict who is going to get what disease, decades in advance. These are dislocations, translocations for society. We can't tell people after the fact: they need to be part of this conversation now or they will not be with us later.

- The experience with GMOs is a great example of what happens if you don't have an ongoing dialogue with the public. There are very real ethical issues, so we need to not just inform the public, we need to dialogue with them. We need to evolve new structures and programs at the federal level, the national level, that will position Canada as part of this exciting revolution.
- Thank you very much for your attention.

QUESTION AND ANSWER PERIOD

FROM THE FLOOR: My question is related to, I guess, something a little more fundamental. We are in such an esoteric realm now that the average person has difficulty understanding what is being really looked at here. When we talk about health, there are some fundamental things such as food, nutrition, diet, exercise, lifestyle. Where does that fit into a lot of this? You talk about prevention. It is my observation that the health field has been so captured by the pharmaceutical industry supported by government – perhaps unbeknownst – that it is hard to get away at looking at any other therapies, any other realms of exploration or other traditions. How would you react to that?

DR. BERNSTEIN: I absolutely agree with you, and point to the evolution of the old Medical Research Council in Canada, which is now superseded by the Canadian Institutes of Health Research. Just look at those two words: medical and health. Those two words embody the whole transformation that Parliament had in mind. The CIHR is not just about medicine, it's about health. So for example one of our 13 institutes is an institute of nutrition, metabolism and diabetes. One of the major functions of our institutes is to develop strategic priorities. So that institute's single strategic priority for the next year or so is going to be obesity research, everything from the genetics of obesity to developing new drugs to deal with obesity. But also, promoting health and the research around how do we promote a healthy lifestyle in Canadians so that we don't become obese and have these diseases, including diabetes and cardio-vascular disease, that come from being overweight. That's why when I talked about prevention, I think increasingly, we are going to see that we can predict who is going to get diabetes or cardiovascular disease. If I knew I was going to have diabetes in ten years, I think I would be much more likely to do something about it now. We all know we are going to die, but we don't do much about it. But I think if you can actually identify, based on genomics, who is at risk of what disease, it is going to stimulate a whole different approach to health and lifestyle.

LOIS STEVENS, INDUSTRY CANADA: Two questions. One has to do with university education. It seems to me one of the major transformations that has to take place is the interdisciplinary approach of university education that you identified, and having worked in a university environment, I know how difficult that is. So I'm curious what efforts are underway to advocate with university presidents to force this interdisciplinary approach to educating young people. The second question has to do with the other end: entrepreneurship. What role does incubating new firms and developing entrepreneurs to take up these opportunities that are being developed out of this new research? How important do you think that is and what kind of efforts are underway in the health sciences?

DR. BERNSTEIN: Two good questions. In terms of the first one, I've had many discussions now with individual university presidents and VPs of research across the country. I think they are very receptive to what we've been talking about and the challenges will be for them – in the context and the history of their own particular universities – to come up with unique solutions that make sense in their culture and their environment. There are two approaches to change; there's the carrot and the stick. At CIHR, we are putting carrots on the table and that transdisciplinary training initiative is the first. We've said, "Here's \$100 million over the next six years to train in a transdisciplinary way." We got 235 letters of intent from across the country, representing close to 1500 researchers. I would have loved to have funded every one of them. They were really very imaginative and really responded to that challenge and they had the blessings of their department heads, etc. For example, one of the ones that we are going to fund is actually a group of bioinformatics investigators from across Canada. There is not a critical mass of bioinformaticians yet in this country, but here is a group who are going to form a virtual school of bioinformatics to create a virtual critical mass. They want to bring together individuals across this country to form a coherent group of trainers.

We are developing other carrots, if you will, to put on the table. I've spent most of my professional scientific career in hospitals and I believe teaching hospitals are actually up to speed on this. They understand the need for a multi-disciplinary approach. For example, the stroke team has an anesthetist, a surgeon, and so on. The culture in a hospital is very multi-disciplinary and certainly the research environments that I'm familiar with in teaching hospitals are inherently multidisciplinary. I think that's one reason our hospitals have been so successful at doing health research.

In terms of entrepreneurship, it's a challenge also. We need role models – success feeds upon success, as you know. One reason I think we need to get our success stories on page one of our newspapers is so that young people see that you can be successful at whatever – whether it's English literature or starting up a biotech company. That's how unconsciously, we all make decisions. We look at what works, and we look at role models. I think we need to have more of that in the media and we're doing a lot you'll notice. Last week, the Canadian edition of Time magazine had a huge story on how fabulous Canada is doing in health research and highlighted individual success stories of researchers. We worked very hard with Time to make sure that story happened and that it was a very positive story. I think we need lots and lots of examples of that. And we need programs obviously, and policies that will encourage us.

SIDNEY FEATHERMAN, INDUSTRY CANADA: In that edition of Time, I think there was another article on the efforts on the way to discover the genome for rice, which I'm told is very complex – maybe even more complex than the human genome. Is plant genomics part of the CIHR mandate or is it being undertaken anywhere in Canada, particularly with its ability to prevent starvation and for food source?

DR. BERNSTEIN: Plant genomics is within the purview of both NSERC and Genome Canada. Genome Canada is funding some genome projects on some very obvious Canadian plants. So that is going on within Canada, but not funded by CIHR. We are funding a lot of human health-related genomics, more directly related genomics.

Key Note Presentation

Building Companies with Emerging Technologies

Dr. Brian Underdown

Vice-President, Science & Technology
MDS Capital Corp.

Brian Underdown is Vice-President, Science & Technology of MDS Capital Corp. In this capacity, Brian undertakes scientific and technical due diligence of investment opportunities and continues to add value in a variety of capacities to partner companies. Brian is also President & COO of University Medical Discoveries Inc. (UMDI) jointly founded by MDS Capital and the Canadian Medical Discoveries Fund. UMDI is focused on pre-seed investments to obtain commercial "proof-of-principle", prior to first round investment. Brian's experience includes senior positions in the commercial and academic sectors as well as on national and international bodies concerned with science policy and university-industry collaboration. Prior to joining MDS Capital, Brian held the position of Assistant Vice-President, Research at Pasteur Merieux Connaught, and Associate Dean Research at McMaster University, Faculty of Health Sciences and the University of Toronto Faculty of Medicine. Brian attended McGill University where he graduated with a B.Sc. in Honours Chemistry and a Ph.D. in Immunology and undertook post-doctoral studies at Washington University in St. Louis MO.

- In his opening remarks for this session, Alan Bernstein contrasted the traditional Canadian self-image of hewers of wood and drawers of water with the major contributions that Canadian scientists have made to the development of the new biology. As a frequent modern "voyageur" to Algonquin Park, I was struck by another image that describes our world in the post-genomic era, rooted ironically in one of Canada's great sites of trees and water. Those of you who make an annual pilgrimage to Algonquin Park's interior know the pleasure of scanning the stars in the emerging night sky after a day's long paddle. A different image awaits you if you awake in the small hours of the morning. At three am under the right conditions, the number of stars in the sky appears to have grown logarithmically. This enhanced image struck me as very similar to the enhanced image of the yeast proteome recently revealed in the Nature articles referred to by Dr. Bernstein. One of these articles represented a major collaboration between Canadian scientists and MDS Proteomics, one of a number of Canadian companies within a growing cluster of proteomics companies in Canada. Fantastic technology such as that being applied to proteomics has resulted in an acceleration of information that appears unprecedented in the history of science. The challenge is to turn this information into knowledge and the knowledge into wisdom. Hopefully, the explosion of knowledge resulting from the elucidation of the genome sequences of humans and other interesting organisms as well as their respective proteomes will lead to new diagnostics and therapeutics as well as strategies to promote health.
- As I migrated from academics to industry and subsequently to MDS Capital in financing emerging and growing companies, I have learned that to grow a successful business, particularly in biotechnology, robust competitive technology is an essential but insufficient condition for success. To cross the finish line, experienced, quality people with management experience are essential. Canada undoubtedly has high quality science but we still lack a critical mass in management experience, although that gap is lessening.

- In addition to high quality management and science, a previous speaker reflected on the importance of public awareness and support for Canadian science and technology. The point was made that Canadian science usually appeared on the sixth page rather than the front page in Canadian media. Manny Farber, a Professor of Pathology at the University of Toronto was fond of saying that the motto of the successful scientist is "early to bed, early to rise, work like hell and advertise." I think that this is true for the scientists at NRC and funded by CIHR, as well as the leaders of Canada's emerging companies.
- In addition to promoting your enterprise, flexibility is a key attribute of successful businesses. Some of you have seen reports from Nexia, (you have even seen Nexia on the front page!) an emerging Montreal-based biotechnology company that MDS Capital started featuring novel technology to create transgenic goats to meet an unmet need in the marketplace created by the genomics and proteomics revolution. It was clear, and still is, that there was going to be an increasing number proteins discovered with therapeutic potential. However, there exists a worldwide shortfall in capacity to produce therapeutic proteins efficiently and cheaply. There was also the possibility of producing proteins that were coming off patent. However, the path to approval of generic protein products as well as new protein products is very rigorous and the time required to take a therapeutic product is often a challenge for a young company. Nexia, like all successful companies, was looking for additional ways to generate revenues as it drove its therapeutic program forward.
- In meeting this challenge, Nexia displayed a key characteristic of successful businesses, which is to develop flexibility in its business model. They realized that the company's technology could also be used to produce proteins for the advanced materials sector and the paths to market for non-medical proteins was likely to be shorter than for proteins designed for human health. The US Military has had a long interest in spider silk protein because of it's potential to make very resistant fabrics for many different applications requiring strength. No one had found a way to make spider silk cheaply. This led Nexia to expanding its business vision to include protein products outside the health area, a decision reflecting the flexibility and nimbleness of its management, qualities that are essential for successful companies and probably more important than the technology itself. Obviously, successful companies must have robust technology, but technology alone doesn't make a business.

- What has MDS Capital learned with respect to the dynamics of the health and life sciences market with respect to building companies with emerging technologies?
- As the previous speakers have intimated, the life sciences business is an expanding opportunity. In 2001, the market approximates \$2-trillion predicted to grow to \$4-trillion in 2006. Why this expansion? There are macro trends in health care. As Alan Bernstein emphasized, we have the luxury of living longer, but along with increased life span comes increased prevalence of chronic diseases. We will accumulate, as we live longer, the chronic diseases of arthritis, hypertension osteoporosis and diabetes to name a few. We will find that a longer life will only be savored if we maintain a healthy status for most of that period. In this new and exciting era, our challenge is to apply wisely new developments to promoting health through better diagnosis, treatment and prevention. As Alan pointed out, health is our most important asset and the commercial opportunities to participate in protecting this asset are many.
- In addition to the demographics, the enormous advances in science and technology make the investment climate in health and life science attractive. In fact, we are basing our own investment future on the convergence of technologies such as nanotechnology, informatics and molecular science that will lead to new solutions in health care.
- However, there are societal issues that will also shape the future of the health sciences industry. The cost of developing new and improved products is growing faster than society's estimated ability to pay for them. Paradoxically, businesses that are built on lower cost as their value proposition find it difficult to obtain financing. New and emerging companies will have to offer better as well as affordable solutions to be successful.
- Competition is fierce and emerging companies must be quick to realize when the market they planned to target, has been served by competing products further ahead in development. An example has been observed recently, in the cardiovascular area. As you know, one of the big advances in cardiovascular disease was the insertion of stents in the arteries that supply circulation to the heart. One of the problems with stents has been the restenosis or reocclusion that occurs in a significant number of patients. This past year, there were at least two companies that reported much improved stents coated with compounds that prevented restenosis. It appears

that the problem may have been solved and as one article commented, playing on the Disney reference, "Honey, I've just shrunk the restenosis market." If this is correct, companies relying on products that reduce the rate of restenosis might have to reinvent their business!

- There has been much written on the need for large pharmaceutical companies to reduce the time and cost it has traditionally taken to bring a product to market. The molecular revolution, has generated a number of enabling technologies that offer solutions to these problems, some focused on efficacy, some on speedily weeding out drug candidates that are likely to have undesirable side-effect profiles. However, companies that bring new technologies to improve efficiency of drug development have found it difficult to extract recurring revenue from a share of royalties on sales of the final product they may enable. Pushback from big pharma on revenue sharing reflects increased demand from multiple solution-providers each demanding a share of the pie for their part in contributing to the accelerated product development cycle time. Because of the reluctance of big pharma to give out royalties, providers of enabling technologies have found that they must transform themselves into product-development companies to become financeable.
- While emerging companies are most often focused on discovery and early stage development, the financial viability of these companies and their investors is also affected by the endgame namely, the clinical trial process. Despite efforts to streamline and shorten the process, times to approval are increasing. When one finally moves a therapeutic product to the pivotal phase 3 trial, success rates are only a little better than 50% - apparently not much better than the flip of a coin! Emerging companies must have multiple product candidates to mitigate the risk associated with the failure of any one product.
- Despite all these challenges, there are still enormous potential opportunities to meet unmet needs. However, one must always identify gaps early to take advantage of opportunity. In fact, I think it's fair to say that if you were going to start a genomics company today you would probably be wasting your time - unless it was in, pharmacogenomics and here, the business models are challenging.
- Proteomics has developed rapidly with an estimated one million proteins to sift through rapidly to find the estimated 10,000 targets or proteins with

therapeutic potential. Canada has generated one of its first biotechnology clusters in the Montreal-Toronto corridor with three major companies and a number of smaller companies devoted to discovering new protein pathways and targets. The window of opportunity in proteomics may be closing rapidly. Which area will provide the next opportunity?

- Many investors are looking at the convergence of technologies for new opportunities to create successful companies. Systems biology, that attempts to integrate molecular pathways with cellular physiology and organ systems will eventually use nanotechnologies, advanced materials and sophisticated computer simulation of biological and clinical systems to produce new preventative and therapeutic approaches. All of this comes with a heavy demand on deep computing and companies such as IBM, have made major investments to meet this need.
- So what are the new realities for emerging companies? There is a short half-life for ideas and technology. There is fierce competition. There is and always will be increased market volatility. There is a shortage of talent. One of the lessons that we've learned in the proteomics area – and I think it's true with all technologies – is you have to build to scale faster. You need a clear business model, one that you're prepared to shift and a clear focus on putting capital to work to create maximum value. Infrastructure should be kept to a minimum. You need teams: everybody has to be aligned, including the investors. You need strategic relationships and you need creative financing. You need patient and knowledgeable venture capitalists.
- The current financial environment requires companies to position themselves as close to the final product as possible as that is where maximum value is created. The greatest step up in valuation occurs when companies have products in late clinical trials. If you're trying to build a company, you have to get closer to that product.
- There are undoubtedly too many biotech companies and mergers and acquisition activity is becoming a common strategy to achieve the kind of growth, depth and breadth of product pipeline and level of value required to launch a public offering.
- In the future, the notion of personalized medicine will become a reality. In order to get there, we will require deep computing and massive information technology until finally, the key information will be reduced, I believe, to a

personal barcode. Each one of us will have a series of barcodes that we might carry around in our wallet. Some of us will have a barcode for diabetes and metabolic disease. Others will have a barcode for stroke and invariably as you live longer you will have multiple barcodes. At that point, the business solutions will be different. There will be new business that will be based on providing the security of such personal information. I believe that while this is the ultimate goal, adoption of personalized medicine with high predictive potential will require much more study.

- MDS Capital and one of its partner funds the Canadian Medical Discoveries Fund are committed to assisting Canadian research institutions develop their inventions for commercial application. In the last six years, we have made approximately 45 seed investments of around \$200 to \$400,000 through affiliated companies such as University Medical Discoveries (UMDI). We've spun out 15 companies from these seed investments that have been financeable. Recently, we have moved to create clustering of companies since it has become increasingly difficult to finance small companies. We've got to build value with the companies that we have already created. We have also pursued another business model where technologies are first funded to achieve commercial proof-of-principle then licensed to growth stage companies where UMDI, the inventors and their institutions all receive equity in an existing company with the infrastructure required to move the technology forward on a commercial path.
- It is my belief that more than capital, Canada's needs are in fostering the entrepreneurial spirit, openness to new business models where research institutions, investors and inventors work together to create critical mass. We must be open to clustering of companies as a vehicle to create enterprises of sufficient size to be successful. And finally, we need to work with government to foster policies that promote each of these goals.
- Thank you.

Key Note Presentation

Cluster to Cluster Linkages: Canadian Fabless Semiconductor and Taiwan's Semiconductor Fabs

Dr. Adam Chowaniec

Chairman of the Board, Tundra Semiconductor

Adam began his career in the 1970s, as a member of the scientific staff of Bell-Northern Research in Ottawa. From there, he moved into engineering management at Nortel Networks. In 1983, he moved to Westchester, Pennsylvania to become Vice-President of Technology with Commodore International, where he was responsible for the development of the Amiga personal computer. In 1986, Adam returned to Ottawa to become President and Chief Executive Officer of the semiconductor firm Calmos Systems. He was instrumental in having Calmos Systems acquired by Newbridge Networks Corporation in 1989. Calmos was renamed Newbridge Microsystems. Under this new structure, Adam served as both its President and as a Vice-President of Newbridge Networks. In December 1995, Adam and a number of key associates successfully negotiated the spin-off from Newbridge Networks of what is now Tundra Semiconductor Corporation.

Adam has served on numerous boards of directors in the United States and Canada, including Amiga and GEAC Computer Corporations. He currently serves on the boards of IceFyre Semiconductor Corporation, SiberCore Technologies Inc., and on the advisory boards of Ottawa Hydro Holdings Corporation and SpaceBridge Networks Inc. Adam is involved in several local business and community initiatives, and his commitment and participation has positioned Adam as a key spokesperson for the high tech community in the Ottawa area. He was the chair of the Ottawa Economic Development Corporation and member of the Ottawa Partnership in 1999-2001. He also serves on the boards of the Canadian Advanced Technology Corporation, the Information Technologies Association of Canada, and the Ottawa Heart Institute and Ottawa Health Research Institute.

Adam has been recognized for his leadership, business excellence and innovation. In 1998, the Ottawa-Carleton Research Institute (OCRI) awarded him with its prestigious Chairman's Award. Also in 1998, the Carleton Board of Trade awarded Adam with its Silver Business Person of the Year. More recently, in 1999, Adam received the Gold Business Person of the Year, a very high profile local business award, from the Ottawa Board of Trade.

Adam holds a Master's degree in Electrical Engineering from Queen's University (Canada), as well as both a Bachelor of Engineering and a Ph.D. from the University of Sheffield (England). Adam's affiliations include the Institute of Electrical and Electronic Engineers and the Association of Professional Engineers of Ontario.

- I think the topic of the fabless semiconductor companies is really an interesting one, not just because of the technology involved, but it's one of the technology clusters that has actually created a lot of wealth in Canada over the last decade. It has also created pretty good returns for the investors that helped build these companies. So if you take my own company, Tundra specifically, six years ago when the company was founded, it had a value of about \$10 million. When it went public three years ago, it was about \$100 million. Today, despite the most vicious downturn we have ever seen in the industry, it still has a value of over \$250 million in terms of market cap. So, a pretty impressive growth – not just for Tundra, but for the cluster.
- I guess I should define a fabless semiconductor company as there are some very specific characteristics. The key one being that it is really about understanding the applications into which the components you make go. The definition of what those components are, how they solve a problem for a customer, and how they add value to that customer, is a key to the business model. You clearly have to be able to build these devices. You have to be able to design them in fairly complex technologies so that you can

implement the finished product. But the differentiating factor is that you do not get involved in the manufacturing technology with which these chips are made. There are specialized companies, foundries, that actually do that manufacturing, mainly in the Far East. But essentially, the model de-couples the risk of the technology and the manufacturing from the risk of the defining and developing of product. If you do this well, the other advantage is that because you understand the application – which inherently means that you have to understand the customer that you are selling these products to – you have a pretty straight forward channel to market. You can approach that customer directly to deliver your product. That also is a key part of the model.

- There is actually quite a wealth of companies in the fabless world. Locally, Tundra, Mosaid and perhaps more interestingly, recently, Zarlink. Zarlink was not originally a fabless company but it has also adopted that model and is largely fabless today. In Canada, we have other players as well: ATI Technologies, which is focused on the video market; PMC Sierra in Vancouver is another very successful public company; and, Genum in Burlington is also moving toward a fabless model. So we have quite a good growth of a group of public companies. In the private space, we have quite a number of startups. Apart from the ones I've listed – and it's not an exclusive list – there are also companies like Spacebridge and Quake Technologies in the gigabit ether space. And there are also quite a number of companies in the pipeline that are currently negotiating for funding, which I think will appear on the map very shortly. So it is still a very active space.
- One of the characteristics of these companies, and of Tundra in particular, is that they are primarily communications applications driven. They serve a very broad base of applications, but are largely tied to the communications sector. So if you look at the whole communications infrastructure space, it consists of a number of levels. Everything at the bottom from the LANS and office solutions and routers, through to switches, right up to large toll switches and cello base stations. These fabless semiconductor companies are essentially delivering solutions to various levels in that space. People like Quake and IceFire are very much in the customer premise side, meaning that they are high volume and provide relatively low-cost equipment. People like Tundra are more the middle and upper end. There's a whole wealth of applications that these companies are tying into.

- The customer base for these products are the large infrastructure companies that are building that communications infrastructure. Companies that used to add to the business model, in that they were blue chip companies with very deep pockets. Unfortunately, in the last year, even those guys have proven to be a little bit vulnerable as well.
- So what makes this business model particularly attractive and why is it worth looking at? Well first, as I mentioned in the beginning, the knowledge base of the end applications – the knowledge of the customers' problems – really is the key. The model leverages technology that other people develop. So it splits off the development of the process technology and the fabrication technology from the understanding of the end applications and from your ability to design complex chips. In doing that, it reduces the investment risk. It is very easy to compound risk by mixing up technology with product development. This model clearly splits the two things apart and therefore also gives you a relatively direct channel to market for a reasonably modest investment.
- In terms of investment risks, the principal risk in this model is that you have identified the real problem that you are trying to solve for your customer – that the market ideal that you've developed is correct. The secondary risk is that you can only really design this technology once you've defined it. So there is a design risk. There is a risk of having a management team, this is common to all start-up companies and this is a really serious problem. Even in the Ottawa area we have great technologists and we have a lot of technical knowledge, but we still have very weak management teams. It's very hard, even today, to recruit senior business people, in terms of marketing, in terms of sales, or even in terms of good CEOs. The other investment risk is that the time to market for this model is actually quite long. This is something that is not well understood, but there is a concept called Design/Win. If Tundra or one of the other companies develops a chip, develops prototypes, it takes about 18 months to do that. Then you go to market with those prototypes, and when a customer such as a Nortel says, "Yes, I'm going to build your prototype chip into my next product," that's a Design/Win. But at that point, there is still no revenue. When Nortel begins to develop their product, field trial their product, and begins to take that product and ramp it in production, you start to see revenue growth. The elapsed time between when you get that Design/Win, when you see revenue growth is usually a minimum of two years. It can also be longer. As a result of that, you've got no cash flow from any revenues of this

product that you invested in for that period of time. The good news is, that if you withstand that, the lifetime of these products is actually surprisingly long for the pace of change in technology. Some of these things can be in volume production for five years or longer. This is again a key part of this business model. Depending where you are in the infrastructure, whether you're at the customer premise end or at the high end, the length of time it takes you to get to market is different. At the premise end, it's a little faster and at the top end, it's a little slower. But it is in the two years plus time frame.

- So what created the cluster in Ottawa specifically? The first thing is the depth of telecom and datacom knowledge that was built here over close to 50 years. It's that knowledge that enables you to pick out the ideas and the applications around which you build companies. Secondly, there has been semiconductor activity here since Microsystems International and since Canada was in the microprocessor business back in the 1970s. That has built some management depth, which has helped the problem of recruiting management teams over the years. More recently, the business model has been validated by the fact that there has been lots of venture capital investment in this sector and indeed there have been successful IPOs. Successful IPOs are critical in that they are the things that build future management teams. If we allow as many companies as we have in the last decade, not to go IPO but to get bought out and create R&D branch plants, we'll lose the ability to generate those management teams for the future and that's a very serious problem.
- I believe the cluster will continue to grow, first because of the critical mass that is already here, and secondly, because of the downturn. The OEMs – those large companies that I showed you earlier that are mainly the customers that we interfaced with—they don't have the ability to design this stuff themselves anymore because of the downsizing they've seen over the past year or so. This is creating huge opportunities for new start-ups to tap into these market sectors. Secondly, there is a migration possibility. This business model is applicable to more than communications. It's applicable to the convergence into biotechnology and there are lots of new places where we can look at making this model fit. We have to be careful to understand that this model works because it separates product development from technology development and identifies and separates those risks. That's a key point. There is one concern going forward, which is the cost of the technology. We're now at a point where a half of a micron or a quarter of

a micron, it was about a \$200,000 to \$300,000 investment to build some prototypes. With an average IRAP grant of \$200,000 to \$300,000 you were kind of in the ball park. Today we are operating at 0.13 microns, where a single mass set is \$US1.2 million. IRAP, as good as a program as it is, is completely unable to deal with the magnitude of the investments that have to be made. As we move below 0.1 micron and we get beyond the optical processing realm, I think those costs are going to continue to skyrocket and that's going to be an issue in terms of investing in new fabless opportunities.

- The last thing that I should mention is that because of the de-coupling of the technology, there is also an implicit understanding that you are going to be able to source the technology from somebody else, and that has worked very well up until now. The foundries that build these wafers have been very responsive to supporting small companies, and as a result of that it's been relatively easy to get good pricing and good economics, even as a very small start-up. There is a risk that that is going to change in the future as well, as more and more large companies. Companies such as Zarlink here, and US companies such as Motorola, are actually adapting the fabless models themselves and are using technology from the foundries. This may be a concern for getting supply for the smaller companies. The other, perhaps the last, point on the downside is the economic issues of the last year. It's never been a problem in the last five years in terms of going up, selling product to a large OEM like Nortel or Cisco or Lucent. Irrespective of what your size was as a company, and irrespective to what your positioning was in terms of your balance sheet. Today that has changed again and it's much more difficult for start-ups who have very thin balance sheets, who are at a very early stage, to convince some of these large OEMs that they should buy product from them. They have to find a way to convince the large OEMs that they are going to be around in five years time. Nevertheless, despite those issues, I think the fabless model is alive and well. I think the technology cluster in Ottawa and in Canada is very much alive and well. I think there is still a lot of wealth to be created out of this industry sector.

- Thank you.



Key Note Presentation

Staying Ahead of the Game: Acting on Growth Opportunities in Emerging Technologies

Dr. Martin Sumner-Smith

Vice-President, Pharmaceutical Solutions, OpenText Corporation

Martin Sumner-Smith, PhD, is currently Vice-President, Pharmaceutical Solutions, Open Text Corporation. In 1996, Martin founded Base4 Inc. and served as its President & CEO until its acquisition by Open Text in 2001. Base4 pioneered the application of knowledge management technologies to facilitate the drug discovery and development process in pharmaceutical and biotechnology companies.

- What I thought I would do and actually was originally invited to do was talk a little about the history of Base4's bioinformatics company and compare it to a cohort of other companies. Then I'll lead in to how we got involved with OpenText and how we were acquired by OpenText and some of the consequences of that, using OpenText as another example of an IT-intensive company that's been very successful in Canada. So I would subtitle this 'Surfing Stories'. There's a lot of discussion about the technology waves and, frankly, if you've been riding any of those waves, of course you know there are sharks out there, and even when you get to shore there are sharp calls and rocks and so forth. So, there is a degree of navel gazing here in my talk, which I hope will be useful and informative for you.
- So I'm going to talk about two companies. One is OpenText, the company I now work for, which was founded in 1990 in Waterloo. Base4 was founded in 1996 in Mississauga. Of course, the link between the two is that OpenText acquired Base4. Two companies, on the face of it, involved in very different businesses. I will try to make clear to you why those are now related. Base4 was one of the first companies founded, in what we now describe as the first wave of the bioinformatics companies, in 1996. A number of companies were formed around that time, and I'm going to go through a few to discuss what's happened to them. It was a rather interesting climate at that time and it's a little hard to remember how climates change. But in some cases it's a case of déjà vu.
- There was a lot of fear at that time. With sequencing, people were very concerned essentially about the potential that companies would be grabbing and about how the patent position that would prevent their competitors from competing and developing any drugs in the future. There was a lot of fear there. There was a lot of money for sloshing around, aimed at reducing people's fear and giving them some level of comfort. In about 1994 George Post, who at that time was the president of SmithKlein Research, had said, "While we missed the boat as a big farmer on biotechnology, we're not going to do it again in the bioinformatics era. We are going to put more money and we're going to beat these guys, and there won't be a bioinformatics industry." It was an interesting perspective. It was wrong, of course, but that was, again, part of the climate.

- Even back then, we talked about convergence and the combination of biotechnology and information technology. At that time biotechnology was very successful, as was information technology, and there was a sense that the two of them together would be that much more powerful and that much more profitable. That seems logical, even in hindsight
- Unfortunately, that vision persists. I was invited last year to speak at a conference in India. As you may know, the software business in India has been very successful at outsourcing programming and they decided the next big wave was going to be bioinformatics. I had at least 50 companies come up to say things like "We've just spun off a group with 100 programmers: what should we be doing?" I said, "Well, have you counted the number of bioinformaticians in North America? It doesn't equal many more than the people you have dedicated to this." They had this concept that bioinformatics was going to be as big as information technology, which is clearly ridiculous. But that was the sense and we had that in the mid-1990s as well. There were any number of analysts saying then and some are still saying now – and it was completely wrong – that the market for bioinformatics-type technology was going to be \$US2 to 4 billion by the year 2000. We've gone past 2000 and it hasn't happened.
- In bioinformatics, there are two general approaches. One is to sell subscriptions to information that has been derived by genomic technologists. So, companies like Human Genome Scientists, Inside, and Sierra had a business model, where they would invest more money, more equipment and larger teams to get information before anyone else – particularly before it was available in the public domain so that you could grab those patents. At that time, it was a very successful model because large pharmaceutical companies were prepared to invest multimillion dollars to get a piece of a database that nobody else had access to, without paying that amount of money.
- The other approach was to say, "All of this analysis of the data depends on software and what we really need to do is to sell software tools." That was the genesis of the first generation of bioinformatics companies that I've talked about. So if you analyse this as a cohort, there were a number of companies around at that time. Some formed in 1996, some a few years before, but they really got started at that point with these first venture investments. One is a company called Molecular Applications Group, which focused on protein visualization and applying that to understanding the differences discovered in genome sequences.

- Another company was called PanGeo – these first two companies were based in California. In Oakland, PanGeo was focusing on database integration. As you know, there was a wealth of different databases. PanGeo's view was that many of these databases were flat file databases and you could use them much more effectively if you imported them into a relational database system. Another company called NetGenics was saying that one of the challenges in organizations was the multiple application programs they already had. Another company that got started about a year later was called Sonomex. Their aim again was applying bioinformatics across an enterprise. My own company, Base4, which I started in 1996 with some support from Allelix and Canadian Venture Investment, focused on a different type of enterprise collaboration.
- One of the themes that comes through, when you look at this in hindsight, is that we already knew at that point in time that selling software tools to a scientist for \$1000 for a CD or a few floppy disks was not going to make us much money. What we needed to do was to sell to the large organization, the large pharmaceutical companies, and the large enterprises. They generally had problems in terms of coordination. Whether it was coordinating access to data, coordinating the use of tools, or the thing that I was particularly interested in, actually taking benefit of the tools and insights that they had to collaborate better.
- The industry is incredibly inefficient. It is very profitable and has been able to be inefficient for very long periods of time. You see that throughout the organizations. They became very efficient by being aggressive and making decisions, so that creates a climate where most drugs are cancelled. It also creates a climate where it's very difficult to have anything that's innovative. So some of the most important challenges in the organizations are not the technology, but what they do with the results they discover and how they can actually benefit from it.
- So what went wrong? From my introductory comments, you realize in a sense that things went wrong. To be a little provocative, I would say that it was too much government funding. That's not criticism of governments per se, but to realize that it created a climate where there was a lot of money – at one point even putting \$250 million into academic researchers. What that meant was people were saying, "This is great stuff that you're doing, but I really don't need to pay for it, I can get it for free. You want me to pay, how much?" This was in contrast to what had happened in the 1980s when

people had developed some chemical informatics tools. The early visualization tools where the subscription prices were something like \$40,000 a year for scientists. There was no possibility of that in the bioinformatics domain. Most of these companies were really talking about \$5 million a year per pharmaceutical company as a client. Concurrent with that was the rise of the Internet and, particularly, browser technology. What that meant was that again information was more widely available. We were trying to sell tools and software tools and software capabilities that were being developed in an academic setting. Now that academic setting – without any particular marketing budget – could actually mount those tools on the Internet and make it available to people for free. So again, companies were saying, "This is very interesting, but we already have access to that kind of stuff." It made commercialization of this technology, as important as it is, very difficult. What that meant was, that if you took, in classics of dot.com strategy at that point, let's make this information free on the Internet and we'll charge customers later, you were competing with people who had no intention of ever charging.

- One example is the application service provider model, in which you basically take care of managing the whole computer infrastructure and people just use the Internet to securely access it. You could manage their information. There are still companies thinking that they can sell that concept to biotechnology and pharmaceutical companies. But basically those companies now want to manage their own data – especially in a biotechnology company, where information is the crown jewel. Even if they don't do as good a job, there is something psychological about having the information on site. Then there was a move to various kinds of information portals.
- So how do those companies that I mentioned in that first cohort respond? PanGeo, which had been essentially a system integrator focussing on development database technology, had a big problem. Every customer that they went to had a different environment and their software never worked. So they said, "If we create the same environment, we can at least control it." Then along comes the dot.com era and the concept of portals, and so they converted themselves over to a company called Double Twist.com, which was a portal on the Internet where the scientists could get access to the latest pre-analysed information and the latest tools, etc. in a controlled environment. PanGeo just missed the IPO window. If they had done that about three months earlier, they would have raised a lot of money. But it

probably wouldn't have made any difference in the end. In the case of Base4, we decided that one of the biggest problems we had was that the number of bioinformaticians in both the academic and commercial world was very small. What we really needed to do was sell to all the people involved in research and development, not just those people in bioinformatics. We needed a much larger group, so we decided to focus on a collaboration and built on what we were doing on top of technology from OpenText.

- Pangeo/DoubleTwist still exists. I would say there have been heavy layoffs, lots of cutbacks – and they do a lot less than they have tried to do in the past, but they are currently around. Probably mostly attributed to the fact that they had some blue chip venture capital investors who aren't prepared yet to wind up the company and are still looking for an exit strategy. NetGenics was acquired by one of the companies I haven't mentioned – Lion. Lion is a very interesting German-based company that started a year or two after the rest of us. They had a strong academic base and, more importantly, they had a strong funding base in Germany. They claimed to be a large software company when, in fact, the bulk of their business was a service-based business doing sequencing under government contract. They were able to acquire NetGenics. NetGenics raised about \$65 million and acquired about \$17 million at the beginning of this year. So you ask the question, what's happening to Lion? I had a look last night. Lion lost 10-fold in its valuation and is missing its revenue targets and so forth, so I'm not sure how long they will be around. What else happened? Sonomics – this was the UK-based company that I mentioned – raised about \$8.2 million. They were acquired by Exelos in 2001 for about \$5 million.
- During the dot.com era, I turned down an offer to buy Base4 for between \$20 and \$50 million. It would have been a stock-based purchase. The company that was looking to acquire us, their stock dropped 100-fold. So it actually wasn't quite such a good deal. I would have had to hold the stock for at least six months and it was during that six months that the devaluation occurred. We were eventually acquired by OpenText at the beginning of last year (2001).
- So what are the outcomes? A few other companies, and sort of remembered companies, are probably better off. So in preparation for this talk, I decided go back and look at what was happening to them. One I knew about quite well, Genomicon, which had been successful in going public, raised

\$120 million. It was based essentially on pedigree analysis of technology coming out of Cold Spring Harbor. There were big warning signs of course, they had perfect timing in terms of raising money. They only had \$800,000 in annual revenues at the time they raised \$120 million. Big surprise, their revenues didn't go up and they were eventually acquired by a biotechnology company for the value of the cash they had in the bank. In fact at one point, they were trading for half their cash value, which I wish I had been paying attention to and invested in at the time.

- Another interesting company, InforMax, had been selling a software suite to scientists. It was quite successful large and small base, but for the kind of \$1000 to \$2000 price range. One of the things that often happens is that a new management team comes in saying, "You know, we could turn this into enterprise software and people would pay a lot more." InforMax had rapid revenue growth during the late 1990s following that model. They were able to go public, which of course means that I have the benefit of being able to look up how their share prices are doing and it's the same kind of story. It's been dropping off about 30-fold so far and, in fact, it doesn't look any better because as of April 4th, the latest press release announced that they have missed their revenue targets. In fact, their revenue was a 44 per cent decrease over the previous and the main reason for this was that they were not able to sell any of the enterprise software that they had been selling in the past. So those large organizations that were buying this conveniently packaged software for a significant premium apparently noticed that fact and stopped buying.
- What are the autopsy results? I would say, first of all, the market was grossly over-estimated. It's not a multi-billion dollar market. We've seen some trillion-dollar figures, that's a nice big number, but that talks about the budgets of all of the hospitals and so forth. Look at the pharmaceutical industry, which worldwide invests something like \$110 billion in R&D. About 5 to 10 per cent is invested in IT. Let's call it \$5 billion dollars. That total IT investment is, of course, running the infrastructure in the companies, buying hardware, networks, computers, etc. Buying database software, Microsoft office, all of the standard tools etc. Then add on the specialty tools needed by a wide range of different scientists, including the bioinformaticians and biologists, chemists, etc. So if you look at the leading companies, of which there are only a few, and their annual revenues, I can account for probably \$250 million. There is probably \$350 million right now invested in software tools for the area of bioformatics.

- Some of that early buying momentum was driven by fear. Fear subsides. That is also true in the database subscription area. People now recognize that they didn't get such a huge advantage by having an 18-month lead over everyone else. As I've described before, internally the companies were not able to act on this information. Essentially, the technology honeymoon was over, and if you were looking at it in a hard-nosed fashion, your return on investments was quite limited – at least in the near time.
- What I found a few years ago when visiting some of these pharmaceutical companies, was that the bioinformatics groups had unlimited budgets. They were basically the darlings of the company and expected to achieve great things. At the same time, they thought that culturally they had nothing to do with the rest of the organization. I would present the software to them and they would say, "Well you should go talk to the people involved in drug discovery." I used to think, "Excuse me, you are the front end of this process." Of course, they had come in primarily with an academic background with a lot of money. That environment has changed substantially. But if you wanted to also look at the industry, we have seen how expenses are growing extremely rapidly. We have also seen that there has not been a corresponding increase in the number of drugs coming out of the companies, or the profitability of those drugs. Interestingly enough, we saw all this before and I think we're in the process of seeing it again. If you look back in the early 1980s when computers were first applied to drug discovery, there were more than three dozen companies by the mid-1980s. In the beginning of the 1990s there were six, now there are three. Interestingly enough, those three companies are still around and they are primarily the ones acquiring all of the previous bioinformatics companies etc, with the exception of one that I mentioned. So, we've seen it before and I'm sure we'll see it again around genomics, etc.
- OpenText was founded in 1992. It is not as well known in the pharmaceutical industry as I would like, but that is changing very rapidly. This profitable company has \$90 million in cash at the moment, and 1100 employees distributed globally. This is an interesting thing because the company is extremely distributed. We use our own software and most of the people in the company work from home. Ten years of growth – at an average of 40 per cent compounded yearly – as an information technology company. The company originally grew out of a partnership of research done at the University of Waterloo to index the Oxford English dictionary. How would you find index terms, or search for key

words in the Oxford English dictionary? Out of that came one of the early search engines, which OpenText was known for.

- OpenText made what looked like a dumb decision a few years ago. With that search engine, they decided, "Well, that's going to be a commodity and so we should move out of the search engine area, before the Internet portal companies came along with huge valuations." Of course you know what happened to them, so it was a pretty smart decision. Combining search engine technology with a document measurement technology led to what the company is based on now. Meanwhile, it was really one of the first companies in the work search area. In fact, it developed the first search engine for Yahoo. OpenText went public in 1996, with very modest revenues at that point in time, but it was able to raise the money and then capitalize on that to bring out our flagship product, Livelink.com – Livelink 7. At the time, it was so novel we were promoting the concepts of Intranet technology and the investors said, "Excuse me, that's wrong it's Internet." So we had to explain the difference. For a while, we used this logo that emphasized that we knew there was a difference between Internet and Intranet and we were doing this new thing, which was called the Intranet. We had a number of other firsts including being able to use workflow tools. These are actually playing very well now in the pharmaceutical industry, where we are applying processes to automate things that happen in industry, especially around decision making. Livelink8 followed shortly.
- These are some of the data challenges. How do you get case report forms in an ongoing clinical study? How do you manage them and how do you perform safe reviews, etc.? Other examples of technology now being used by organizations such as the National Institute of Drug Abuse include Extranets, which support a collaborative environment between researchers in the organization and funded researchers in clinical studies. More recently, and this is one of the things that has been fun for me, we have actually seen companies starting to adopt this technology to help make decisions better. We have all of these products on the way that help organizations ask, "How do we allocate resources and make the best decision?"
- We also have been supporting the electronic signature process, which is a major driver around the industry. It's estimated that 40 per cent of all IT purchases by the pharmaceutical industry are driven by regulatory requirements or compliance. That's not something you hear when you hear people talk about bioinformatics. They are coming from a technology needs

perspective. The industry has strong needs to be compliant to regulations. We have other examples of integration with wireless devices. More recently, we developed a product that is included in Livelink that allows you to hold online meetings. What's fascinating to me is that you can save those meetings and refer back to them, so you are able to determine when you made a particular decision. They are saved, they are searched and so forth.

- So, what are some of the elements that have made OpenText successful? Strengths in document management in Canada. The company went public at the right time and was able to make extensive use of mergers and acquisitions. I think OpenText has acquired something like 20 companies, including Base4 as I've described, to manage the growth of the company and has adapted quickly to changes to those technology trends that I was talking about. So, ask the question: "How has Base4 been doing in the OpenText environment?" Unfortunately, we are in a quiet period in the quarterly announcements, so I can't tell you precisely, but there has been a substantial increase in pharmaceutical revenues as part of OpenText. Some of this is timing. I was doing a lot of missionary work, telling people about the importance of knowledge management and its application to the industry. If you look at the Dilbert cartoon from back at that point, knowledge management was an oxymoron. We had promoted a vice-president from knowledge management in a pharmaceutical company who would then call us up and say, "What is this knowledge management thing that I've just been put in charge of?" So, our customers were people that didn't know what they were doing and had no budget. That is changing, I'm glad to say. It's been driven by requirements and regulatory climate and is one of the challenges that we face today in the pharmaceutical environment. We had great technology, we were a small company that was not currently very stable. Pfizer is one of our current customers and they said, "You know when you were in Base4, we loved what you were doing but there is no way we would have bought from you. Now that you are part of OpenText this is great stuff, we are buying from you." The global presence is really key. These companies need support around the world. If they are using your components and software in their infrastructure, they need to know they can get support 24/7, and there are people locally who can arrive within a few hours to fix things if they need fixing.
- Thank you very much for your attention.

Key Note Presentation

Technology Trends

Arup Gupta
President, TCS-America, USA

Arup Gupta oversees all operations in North and South America and reports to the Chief Executive Officer of TCS in Mumbai, India. Gupta has been with TCS for more than 20 years and has been instrumental in growing several relationships. He established TCS's relationship with Oracle for distributing and marketing their database products in India, and contributed significantly to establishing Oracle as the premier database product in India. In addition, Gupta led TCS-America's business development initiative on the West Coast. When he was based in Sunnyvale, California, he developed relationships with Hewlett-Packard, Compaq, APL, the Gap, as well as many others.

Until recently, Gupta managed one of TCS's largest development and delivery centers at the Santacruz Electronic Export Processing Zone (SEEPZ), India, with more than 1,000 consultants working on more than 150 projects for clients such as General Electric, Kellogg's and Cummins Engine Company. In addition, he was responsible for getting the SEEPZ delivery center to level four of the Software Engineering Institute's Capability Maturity Model (SEI-CMM) – one of the single largest software development centres to be assessed at this level, and for preparing the centre for level five assessment prior to his promotion to President, TCS-America. Gupta has a master's degree in Computer Science from the Indian Institute of Science and is a long-standing member of the Institute of Electronics and Electrical Engineers.

- Good afternoon. As we are the only possible country from Overseas, I'll just take a minute or so to introduce our company. We are TCS – Tata Consultancy Services. We are a company based out of Mumbai in India. We are the largest IT services and technology consulting company in Asia with an annual revenue of about US\$1 billion. We are growing at about 40 per cent per annum; about 75 per cent of that coming from North America. We have a very large customer base in the United States and Canada, that's about 115 to 120 of the Fortune 500 companies. Most of the speakers have spoken in this forum, basically on bioinformatics. Being an IT consulting company, the statements that I will be making, the perspective that we will be giving, is based on our perspectives, specific to information technology, rather than bioinformatics.
- What I will do, in the next few minutes, is to look at some of the technology trends that are driven by the spending power and the spending pattern of the industry. I'll touch on the business environment in all the industries, not necessarily only in bioinformatics, but mostly the consumers of technology and financial services, the health care and retail, those industries – the conjunction of technology by these industries. Having looked at some of the trends, then we will give our perception as to what companies need to do to leverage some of these trends in technology.
- Just to look back a few months, possibly 12 to 18 months: the dot.com era, the technology was mostly Internet. A lot of IT spending in the telecom sector, including the 'Ciscos' and 'Nortels', saw a lot of growth and a tremendous amount of investment in wireless technology, mobile technology and E-business. So, that was the technology a couple of years back.

- Then came the dot.com bust and the spending patterns changed. What we are seeing now is basically a zero growth industry as far as information technology is concerned. Most organizations are not willing to take any risks: all the non-discretionary spending has been more or less stopped.
- Going forward, we definitely see slow recovery in the North American market, that is US and Canada. It is going to be slow, 7 per cent in 2002 and about 10 per cent in 2003. As I mentioned, most of the spending will come only in the non-discretionary area, where basically the companies have to invest to keep their competitive advantage. Those are the technologies that the companies really need to focus on.
- In our judgement, there are strong technologies, specifically in the IT area. The technologies that will continue to be strong definitely include the optical metropolitan area networks, the management services and the business process management. And definitely the security, particularly related to the information technology. As you may have seen recently, a large number of programmers in Microsoft were sent back to the classroom to study how to write secure code. Security is going to definitely become a technology of the future along with application integration and middle ware. The technologies that will continue to become weaker will definitely be centred around the high-end consulting, because non-discretionary spending is the one that will continue to lag. The customer relations of management will possibly start becoming weaker and weaker. So what will be the effect of all these things going forward? Web services are going to become crucial as more and more information technology is driven by Web services. A case in point is the dot.net services from Microsoft, where they are trying to have a completely distributed network providing seamless enterprise application integration. In our view, some of those technologies are going to become very pervasive, leading to a lot of application integration. What we see is the enterprise nervous system will serve as the backbone for the real-time business activity monitoring.
- Another trend that we are seeing – which everybody is seeing and that most of the IT will evolve around – is customer self-service. We will see more and more portable computers. Human beings are going around with handheld computers or with computers in their cell phones or their watches, where most of the functions can be performed while people are basically in motion. A lot of business will happen from tagging over the Internet.

- The behavior of the business shows that the IT demands will be balanced against expenses. The challenges for the companies will be that we really need to treat the market as an open field. We can not take anything for granted, as we did in the dot.com era, and we have to be very sensitive to return on investment and the total control of total cost of ownership.
- Again in the post 911 environment, there will be a lot of investment in the IT security infrastructure. Demand for secure and distributed networks will increase and large-scale system integration projects will be seen less and less. The use of mobile and wireless applications will continue to increase. That's basically how we see the trends in technology and what IT companies need to do to liberate those trends.
- Thank you.

Key Note Presentation

Connectivity in a Converging Marketplace

Eli Turk

Vice-President, Business Development, Alcatel Canada

Eli joined Alcatel through the Newbridge acquisition, where he held the position of Director, Business Development and International Affairs since joining the company in 1999. Eli brings over 12 years of private and public sector communication and advisory experience to his position, most recently as Senior Policy Advisor to the Government of Canada's Minister of Industry. While with the federal government, Eli played advisory roles on several technical government initiatives related to the information highway and telecommunications industry. He is also founding member of the Canadian Branch/Ottawa Section of Médecins sans frontières.

Eli holds a Masters of Public Administration from the Kennedy School of Government at Harvard University, in addition to a Bachelor of Commerce and a Graduate Diploma in International Development from the University of Ottawa.

- I would like to talk a little bit about connectivity in a converging environment. Now clearly, convergence has been a word that's gotten quite a workout for various people. What I would like to try and do is give you a bit of context for convergence and give you examples of some real applications that are happening in a converging world. I would like to talk to you about the technology and lifestyle issues. I would also like to give you a bit of an insight in terms of the market environment and talk to you about broadband, particularly how we are doing in broadband access in Canada. Then, I'd like to finish off in terms of talking about what we call the 'triple play', which is essentially, voice, video and data, all on one infrastructure.
- People often ask, exactly what does convergence mean? I don't want to make it overly simplistic, but if you recall maybe a decade or more ago, you'd have to go to one particular store to get your one type of good. You'd go to another store down the street and get another type of good. Of course, we developed this whole idea of malls, where you could actually go into the mall and all the different stores would be within that mall. You'll find that of course, in the last three to five years, the whole concept of having one-stop shopping within a store – where you get your core product and you try to attract customers, then offer them the whole range of products – that really tells you roughly what this story of convergence is. Essentially, it is the idea of capturing a customer and trying to offer as many services and conveniences as possible, within one infrastructure and within one marketplace.
- On the technology side, what's happening is that service providers are trying to offer content, which is audio- and video-based, data services, IP services, as well as what we call application service providers and various advertising services. Some of the speakers this morning alluded to the challenges in the marketplace. What are service providers facing in this particular marketplace?

Clearly, there is a focus on increased revenues. Customer acquisition becomes very important, new features, market planning and time-to-market becomes even more important and the whole idea of bundle services, which is the basis for convergence. At the same time, they are trying to use their existing infrastructure and optimize it by getting operational efficiencies, as well as developing economies of scales and bringing convergence that consolidates three areas: voice, data and video.

- Where is that broadband convergence coming from? Essentially, it's a variety of applications. It can be a cable infrastructure, which a lot of you are familiar with. It can be a wireless infrastructure, or it could be a telephone-based or DSL-based technology, which is what I'm going to talk a little bit about this morning. Historically, the telephone companies have been one of the key players coming from the voice side, which is, essentially, telephone service. With the evolution of their services, we are looking at voice, data, and the next step of the evolution will be video. We look at the historical strengths of the cable companies. Of course, cable companies came from the video side and are now moving toward the data side. Now they are increasingly moving to the voice side, which means some cable companies now actually offer voice service over cable infrastructure. Of course, there is a satellite infrastructure as well.
- So what are the market predictions in terms of this whole market segment? Clearly, there seems to be an important market segment of almost 75 million homes as a prediction by 2005 for this technology called DSL. Digital Subscriber Line essentially takes copper wire that you have in your telephone infrastructure and makes it a broadband infrastructure, essentially using the same infrastructure and electronics, both in the home as well as in the local exchange, to provide broadband access. The predictions are that 23 million homes will be served by video over DSL, which is the next step in terms of DSL. Estimations are that the telephone industry will spend up to 2.5 billion on video equipment alone in the next couple of years. The broadband access market will be an important one reaching capital expenditures of over \$10 billion dollars.
- Just getting back to what I was saying in terms of the historical legacy infrastructures in relation to this whole convergence phenomenon. Clearly, if we go back only five or seven years ago, the telephone companies were clearly dominant in the voice infrastructure; the cable companies definitely dominant in the television and video infrastructure. Today, we see the

telecommunications companies moving more into the Internet space and of course the cable companies moving more into the Internet space. So clearly, there is some pretty heavy competition in that middle space, which is the fast Internet access space. If telephone companies continue with their existing *modus operandi*, essentially, this is the kind of market structure that you would anticipate. If you're moving aggressively in terms of putting video on that particular infrastructure, this is the kind of market structure you would see in terms of telecommunications companies moving into both voice and fast Internet, as well as TV and video infrastructure. So essentially, for the telecommunications companies, a key appointment is to try to defend their existing base and their existing customer base. But to do that they have to move beyond voice and data to video services over their existing infrastructure.

- What are those potential services or revenues that these telecommunications companies are trying to capture? Clearly, basic telephone is one that they've captured fairly effectively and have to retain. High-speed access and Internet services are products and services that they are offering today. As they move up the value chain, what are some of the key products and services that they will be trying to acquire or offer? Clearly, basic TV, which is one that is not offered by telecommunications, one that cable companies obviously cover. Premium channels, pay-per-view, movies-on-demand and TV web access, as well as other types of applications.
- So, how are we doing in Canada in terms of broadband access? I think as we are finding this morning in the Innovation Forum, often Canada is not a very well-known story globally. I think you'll find that since Alcatel has come to the Ottawa area and Canada has been under the microscope. A lot of senior executives within the company, as well as other people, are starting to realize that there really are some innovative things happening in Canada and some real leadership in particular sectors, particularly in broadband access. If you look, for example, at Internet penetration, Canada leads the world in terms of Internet penetration.
- It's interesting in terms of DSL subscribers, this technology that takes copper wire and essentially makes it a large pipe. If you look at the worldwide DSL installed base, which is about 10 million lines, approximately eight million of those are in the top 15. It's very interesting to see that two key Canadian players are in those top 15: Bell Canada and Telus. If you look at the footprint across the country, essentially Telus, Sastel, MTS, Bell and Alliant

have been very aggressive in rolling out high-speed Internet services. What's also interesting, is that the cable companies have responded fairly aggressively as well. Shaw has been very aggressive in Western Canada, as has Rogers here in Ontario. Cogeco and Videotron have also been very aggressive in terms of rolling out high-speed Internet access. What that creates is clearly a market phenomenon where the competition drives the services, drives infrastructure construction, and drives new and improved services.

- What is the core offering in terms of video over DSL? Essentially, it's what we call the triple play: voice, got data and the new video services. Video over DSL is going to offer content and residential applications, primarily targeted but not limited to TV viewing. What are specifically some of these types of products or services? Video-on-demand, real-time download, broadcast TV, pay TV, time-shifted TV, video streaming, interactive TV, what we call T-commerce, which is TV commerce, TV mail and caller ID among other services. All this means that if you miss the news, you can basically get it at a particular time that is convenient to you.
- What's driving the business? As I mentioned earlier, clearly it is competition. There is strong competition primarily from the cablecos right now that's driving the telcos to move more aggressively in terms of offering convergent services. There are also new revenue opportunities, no doubt about it. If you are able to offer a larger set of services, you are able to capture more revenue from your existing customer base. Market timing in terms of DSL is rolling out fairly aggressively, early adopters are now rolling out the service. We're assuming some real large rollouts by the end of 2002 that will be able to test the technology and show its real potential.
- In T-mail, one of the favourites is where you get Grandma and Grandpa on the net. T-commerce is the one that is really going to drive the revenue model. No doubt about it, the E-commerce revenue model has had some starts and stops, and clearly it's one that needs to evolve much more aggressively in the next few years.
- What is the architecture in terms of bringing these converged services into the home? Without getting into all the details of the technology, as you can see where there is a whole series of services that come through what we call a D-SLAB – a Digital Subscriber Line Aggregator. This D-SLAB can be about 12,000 feet from any home, so there is some limitation in terms

of distance. With that particular architecture you are then able to bring in a whole series of services including voice, data and video through that particular architecture.

- I just thought I would touch briefly on one interesting thing, given the fact that we're talking about innovation in the region. The acquisition of Newbridge for \$10 billion in May of 2002 was the largest deal ever done by Alcatel. You'll find that most of the employees that are at the Alcatel facility here in Ottawa are former Newbridge people, including myself. What has been interesting is that Alcatel has seen Ottawa as a real premium location in terms of sales and market, manufacturing, as well as R&D. One of this year's flagship announcements was the opening of an Alcatel research and innovation centre. It's one of only six global facilities that is doing really cutting edge, over-the-horizon type research. We have a system where we have a series of projects and a matrix structure where various countries work together. In Ottawa we are working on security encryption and network processing—two elements that are key in terms of rolling out the new infrastructure. In addition to network security, we are looking at privacy, which is another key issue.
- I thought I would finish up with a few examples—real examples that are happening here in Canada in terms of broadband access and rolling out video here in Canada. One of the flagship companies that is rolling out video on DSL or video to the home is Alliant in the Maritimes. They have been offering a service called VibeVision, which has broadcast TV, pay TV, T-commerce and video-on-demand. A lot of people ask, when is this going to happen? Well, it's actually happening now. There are 3,000 customers and subscribers in New Brunswick and Nova Scotia that have signed on to the service. Right now the service offers single TV, but there is definitely a road map to move to multiple TV hookups.
- What this shows is that once you've acquired a customer, often with fast Internet and certain services, a lot of them will move. In this case 44 per cent moved toward premium services again. So customer acquisition is very important, as are retaining the customer and offering new and improved services. Bell Canada has been very aggressive. Any of you who are subscribers to the Sympatico service will be using Alcatel equipment, but clearly they are moving again, up the value chain and a very aggressive roll out.

- What is convergence and what are the main technologies that will offer the platform to deliver those services? Clearly, from our perspective and of course having an important telecommunications cluster in the Ottawa area, DSL is an important technology. There are about a billion copper lines installed around the world. Not all of them will be able to adopt DSL technology for various reasons. However, it gives you a great addressable base of potential customers, globally. The technology is moving very aggressively and is very robust. So you need a technology platform to then be able to offer some value-added services.
- Thank you very much for your time.

Summary of Recommendations/ Issues for Possible Action

WORKSHOP 1

Nascent Clusters: Genomics, Bioinformatics & Nanotechnology

Issues

- How could TPC use clustering for future investments?
- OLSC – OCRI strategic link
- IP generations vs product focus in life sciences
 - long time to market
 - value in intellectual property
- Building life sciences cluster through research infrastructure and strategy in San Diego
- Mentoring is key in building new companies.
- Ottawa: a powerful network for mentoring
- Same pattern in ottawa life sciences as past pattern in it
 - investment growth
 - mentoring
- Proteomics: is it too late for new entrants?
- Is there an opportunity for nanotechnology for Ottawa?
 - selective
 - drug delivery
- Various applications in telecom, semiconductors
- San Diego: planned vs accidental?
 - leadership
 - fundamentals and taking it further
- Carnegie mellon not a hotbed for cluster development (John Hopkins is another example: not happening)
- Moving knowledge from universities to clusters
- Taking more parts in the value chain
 - R&D
 - clinical trials
 - manufacturing
- We need to plan carefully which parts to build
- Key parts of clusters
 - management
 - R&D
 - money/investments
- You must have these
 - Singapore examples

- Role of universities in cluster creation
 - commercialization potential is more and more recognized by scientists
- Opportunity to create virtual clusters (e.g. NCES)
- Funding for technology transfer in universities
- Aggressive pursuit of funding
 - management capacity
- Technology transfer offices have high(er) credibility in San Diego
- Include other elements for incubation
 - business skills
 - networks
 - facilities

PANELISTS

Dr. Alexander MacKenzie

Director, CHEO Research Institute

Dr. MacKenzie received his MD in 1983 and his PhD in Medical Biophysics in 1986, both from the University of Toronto. He is currently with the Departments of Pediatrics and Biochemistry at the University of Ottawa. He received his pediatric certification in 1989 from the University of Ottawa and is a member of the attending staff at the Children's Hospital of Eastern Ontario in Ottawa where he serves as an attending pediatrician and director of research. As a post-doctoral fellow, he studied the molecular genetics of muscular dystrophy. Dr. MacKenzie continues to work on the molecular genetics of pediatric disease with current research focus on the molecular genetics of spinal muscular atrophy (SMA). In 1995, Dr. MacKenzie's laboratory cloned the SMA-related neuronal apoptosis inhibitory protein gene. Dr. MacKenzie is the recipient of Medical Research Council Scientist and Burroughs Wellcome Clinical Scientist awards. In 1999, he was awarded the Researcher of the Year award by the Muscular Dystrophy Association of Canada.

Marc LePage

Executive Vice-President, Corporate Development, Genome Canada

Marc LePage joined Genome Canada at its launch in July 2000. His major focus is to develop and implement strategies for growth of the research enterprise. He is also tasked with developing linkages to stakeholders including governments, other funding agencies, non-profit foundations, the pharmaceutical industry, biotechnology, venture capital and international linkages.

Mr. LePage previously served at the Medical Research Council of Canada (now the Canadian Institutes of Health Research) from 1994 to 2000 as Director of Business Development. His responsibilities included the development of all external partnerships including those with the pharmaceutical, generic, biotechnology and medical device industries as well as with the financial sector and business in general. From 1990 to 1994, Mr. LePage served in the Department of Foreign Affairs and International Trade as Trade Commissioner in California where his activity was focused mainly on the biotechnology industry. Mr. LePage helped to develop a number of strategic alliances for Canadian firms as well as research funding agreements for Canadian researchers.

Dr. Simon Mercer

Institute for Marine Biosciences, National Research Council Canada

Simon Mercer graduated with a degree in Biology from London University in 1986, and went on to complete a PhD in Zoology at Oxford, studying the evolutionary cytogenetics of small mammals. During this time he became interested in computing, and combined chromosomes and computers in his first job, building a database of human chromosome abnormalities, which is still in use by the British National Health Service. Subsequent jobs at the Imperial Cancer Research Fund and the Max-Planck Institut fuer Molekulare Genetik led to a deeper involvement in the emerging discipline of bioinformatics, and to the position of Database Project Leader at the Sanger Institute, and a role in the completion of a number of genome sequencing projects, including that of the human. Simon now manages the Canadian Bioinformatics Resource (CBR), a national network of computing facilities available to Canadian scientists.

Jeffrey Parker

Executive Director, Technology Partnerships Canada

As Executive Director, Jeffrey Parker is responsible for the Special Operating Agency established to deliver the TPC program, which makes strategic investments in high-risk research and development initiatives in order to stimulate economic growth and job creation in key sectors of the Canadian economy.

Prior to joining TPC in February 2001, Mr. Parker was Director of Strategic Operations, Social Policy Development Secretariat in the Privy Council Office. He has held executive positions at the Treasury Board Secretariat, including Acting Assistant Secretary, Senior Director, Social and Cultural Programs Sector. In addition, Mr. Parker served in executive capacities in the Department of Finance, the Department of National Defence, and the Department of Indian and Northern Affairs. Mr. Parker holds an MA from York University as well as a BA from Carleton University.

Ken Lawless

Executive Director, Ottawa Life Sciences Council

Ken Lawless has been the Executive Director of the Ottawa Life Sciences Council since its incorporation in May 1994. The Council is a not-for-profit development corporation for the life sciences sector with a mandate to stimulate growth in the life sciences sector in the National Capital Region. Mr. Lawless has been very active in promoting commercialization of life science technologies and investment in emerging life science companies.

Prior to his current duties, Mr. Lawless was Bioscience Development Officer for the City of Ottawa. In 1988 he was Vice-President, General Manager, and a founding principal of AminoTech, a biotechnology firm specializing in peptides and reagents for research and pharmaceutical and diagnostic industries. Mr. Lawless has a Masters degree in Biochemistry from the University of Ottawa and has conducted research on the hormonal control of gene expression, prostate cancer and artificial blood substitutes.

Mr. Lawless has also served on many provincial, federal and local boards, committees, and task groups including: the National Research Council of Canada's Innovation Forum, the Ottawa Partnership; the Ottawa Hospital Research Institute; the Ontario Biotechnology Task Force; BIOTEC Canada's Science and Technology Committee; the Ottawa-Carleton Human Resources Task Force; Algonquin College Chemical Technologies Advisory Committee (Chair); the Ottawa Community Health Information Partnership; and, the Multidisciplinary Assessment Committee for the Canadian Foundation for Innovation.

Dr. David Wolfe

Professor, Political Science, University of Toronto

David A. Wolfe is Professor of Political Science at the University of Toronto and Co-Director (with Meric Gertler) of the Program on Globalization and Regional Innovation Systems (PROGRIS) at the Munk Centre for International Studies. PROGRIS is the node for one of five subnetworks of the Innovation Systems Research Network (ISRN), funded by the Social Sciences and Humanities Research Council of Canada. He is National Coordinator of the ISRN and the Principal Investigator on its recently awarded Major Collaborative Research Initiative on Innovation Systems and Economic Development: The Role of Local and Regional Clusters in Canada.

He holds a B.A. and an M.A. in Political Science from Carleton University and a Ph.D. from the University of Toronto. His past research has examined the

implications of technological change for skills, occupational requirements, education and training. From October 1990 to August 1993, he served as Executive Coordinator for Economic and Labour Policy in the Cabinet Office of the Government of Ontario. Upon his return to the University of Toronto in 1993 until 1997, he was a research associate in the Canadian Institute for Advanced Research's Program on Law and the Determinants of Social Ordering. Since 1995 he has served as a member of the Advisory Committee on Science and Technology Statistics for the Science, Innovation and Electronic Information Division at Statistics Canada. His current research efforts focus on the nature of regional innovation systems and knowledge transfer in local and regional economies.

In 1997, he co-authored a report on The Socio-Economic Importance of Scientific Research to Canada for the Partnership Group for Science and Engineering, funded by Industry Canada. In 1999, he completed a report on Government Support for E-business: Comparative Experiences for the Canadian E-business Opportunities Roundtable and the Electronic Commerce Task Force of Industry Canada. His recent publications include *Innovation, Institutions and Territory: Regional Innovation Systems in Canada* and *Knowledge, Clusters and Regional Innovation: Economic Development in Canada* co-edited with J. Adam Holbrook, and *Innovation and Social Learning: Institutional Adaptation in an Era of Technological Change*, co-edited with Meric Gertler.

WORKSHOP 2

Vital Growth Strategies: Photonics, Wireless, Fabless Semiconductor

Issues

- Focus on SMES
 - research links
 - growth of IPO in Ottawa
- Foster access to common purchasing & other services
- Strategic marketing
- Access and training via H.Q.P.
- Promote and increase mentorship
- Cluster ecosystem
- Entrepreneurship

PANELISTS

Jeffrey Dale

President and CEO, Ottawa Centre for Research and Innovation (OCRI)

Jeffrey Dale brought several years of technical and business experience, coupled with community involvement, to the president's position in January 2002. Before taking the helm at OCRI, he leveraged the benefits of his OCRI membership to enhance his business goals at several local technology companies. Mr. Dale joined OCRI from his position as President, KOM NETWORKS Inc., a fast growing company focused on providing innovative data management strategies. Previously, Mr. Dale was Vice-President, Business Development for Peleton Photonic Systems Inc., an innovative startup company delivering solutions for the next generation of optical networks. He had an active role in the company's set-up and product development phases, and also helped secure major financing and oversaw the development of Peleton's industry-leading optical R&D facilities.

Previously, Mr. Dale was the Vice-President of Sales for SHL Systemhouse (Canada/UK). Throughout his 14 years with Systemhouse, he held numerous management positions in sales and business operations of the company. He is an active member of the Ottawa business community and volunteers his time for a number of community service activities. Currently, Mr. Dale is a member of the Board of Directors for the Ottawa International Airport Authority, the Board of Governors for the University of Ottawa, and is Chair of the Royal Ottawa Health Care Group.

Ray Novokowsky

President, Canadian Photonics Consortium

Mr. Novokowsky has over 26 years of experience in science, communications and high technology. He holds an Honours degree in Biochemistry and Bachelor of Science in Electrical Engineering. Previously the CEO of Advantera and Chairman of the Ottawa Photonics Cluster, Mr. Novokowsky has also held a number of senior-level positions at Mitel, AMI and Newbridge Networks (now Alcatel). Mr. Novokowsky has a strong background in developing and maintaining information networks. He understands the key drivers for IT managers, carriers and product development on a global scale.

Mr. Novokowsky's global insight in communications comes from tenures as AVP of IT for Newbridge's Asia Pacific division and Director of Sales and Program Development for Newbridge Eastern Europe. His responsibilities included business development and technology partnering for the core switching division. The combination of his extensive experience and proven ability to execute successfully has earned Mr. Novokowsky a reputation for delivering superior customer service and value. Throughout his career, he has demonstrated solid leadership skills, and has energetically inspired and motivated his colleagues and employees. In his role as AVP Technology Partnering in the Newbridge Corporate Business Group, Mr. Novokowsky extensively researched, analysed and assessed the commercial applicability of a variety of optical technologies and applications as they relate to the future of the communications industry. Mr. Novokowsky is currently teaching "Trends in Photonics" at Algonquin College and is also the CEO of an early stage next-generation photonics company in Ottawa.

Dr. Darin Graham

President and CEO, Communications and Information Technology Ontario (CITO)

In October 2001, Dr. Darin Graham was appointed President and CEO of Communications and Information Technology Ontario (CITO), an organization that strengthens the global performance of Ontario's IT, digital media and communications sectors by facilitating partnerships between post-secondary academic research institutions and industry. Dr. Graham joined the organization in 1999 as chief operating officer. In that role, he was responsible for building a strong business development team for CITO and for the ongoing operations of the organization.

Prior to joining CITO, he was the director of research and development for ADT Security Services. There, he was responsible for company-sponsored research projects in areas including web-based security systems, digital video/vision products and

speech recognition systems. Earlier in his career, Darin managed the Robotics Group for Thomson-CSF Systems Canada Inc. Responsible for all technical, programmatic and commercialization issues related to robotic projects, Darin coordinated with senior management and researchers from a variety of agencies. As a research engineer with the Canadian Space Agency, Darin led research in artificial neural networks for the real-time control of robotic manipulators. His academic achievements include a doctorate in aerospace engineering from the University of Toronto.

Kamal Bhadada

Mobile Computing Business Initiatives, TCS - America

Mr. Kamal Bhadada spearheads the Mobile Computing Business Initiatives for TCS in Americas. In addition, Kamal is President of a TCS Multimedia Venture, Innovatv, in San Diego. Kamal has been with TCS for over 15 years and has co-authored patents in the area of multimedia techniques. Kamal holds a Bachelor's degree in Mechanical Engineering from the Institute of Technology, Banaras Hindu University, India.

Tony Mascioli

Chief Technology Officer, Spacebridge Semiconductor

With over 15 years experience in research and development, Mr. Mascioli has a strong background in the development of wireless and baseband communications products and services. He began his career as a hardware engineer designing RF, analog and digital hardware for advanced radar systems. Throughout his career, Mr. Mascioli has studied and designed algorithms for spectrum management and image processing, signal modulations in the HF and VHF frequency bands, emergency location transmitters, and other RF, analog and DSP processing hardware. Mr. Mascioli holds a Master's degree in Electrical Engineering from Queen's University.

Tim April

Electronics and Advanced Technologies, Business Development Bank

Mr. April graduated from the McGill University with a Bachelor's degree in Electrical Engineering in 1983. Following his graduation, Mr. April worked as a hardware engineer in the field of Robot Vision. Before joining BDC Venture Capital in 2002, Mr. April spent 17 years in the semiconductor industry, having held various sales and management positions with Texas Instruments, LSI Logic Canada, LSI Logic Europe, Broadcom and, most recently, as Director of Enterprise Accounts with Multilink Technology, a recent IPO Company serving the high-speed semiconductor 10G and 40G optoelectronic market space. Mr. April is now responsible for the Electronics and Advanced Technologies portfolio in Ottawa for the BDC.

Tyler Chamberlin

Group Leader, PRIME-CRIC, University of Ottawa

Tyler Chamberlin is Group Leader on the joint PRIME (Program of Research on Innovation Management and the Economy) – CRIC (Centre for Research on Innovation and Competition) Telecommunications Research Project. Mr. Chamberlin is a doctoral candidate at the University of Manchester (CRIC) and lectures on International Management and Technology Strategy at the University of Ottawa.

Mr. Chamberlin's research within the telecommunications industry seeks to address issues of: 1) the boundaries of the firm (including supplier networks and outsourcing relationships as well as the spatial distribution of firms), and 2) firm survival through radical changes in the market (be they of a technical, organizational or product-based nature).

Appendix A: Roundtable VII Agenda

April 8, 2002

- 17:30 **Registration**
Networking Reception (Hosted by the Canadian Photonics
Fabrication Centre, NRC)
- 18:30 – 18:50 ***Driving Future Growth: Creating Waves***
Mike Lazaridis, CEO, Research in Motion (RIM)
- 18:50 – 19:00 Certificate Presentation Ceremony for Vitesse Graduates

MIKE LAZARIDIS

President & Co-CEO
Research in Motion Limited (RIM)

Mike Lazaridis, founder of Research in Motion Limited (RIM) serves as President and co-CEO and oversees all product development and operations at RIM, and is responsible for the development and ownership of several patents for Digisync, software code and radio technologies.

Mike has been honoured with the following awards: eWeek's eXcellence Award for Best Wireless Productivity (2001); Lotus Advisor Magazine Editor's Choice Award for BlackBerry's Usability & Integration with Lotus Domino (2001); PC World's World Class Award, naming BlackBerry the Best Wireless Communication Device (2000 & 2001); InfoWorld Magazine's Product of the Year Award in the Mobile Computing category for BlackBerry (2000); Smithsonian Award: ComputerWorld (1999), which includes the acceptance of the RIM Inter@ctive Pager 950 into the Smithsonian Institution's Permanent Research Collection of Information Technology, the world's premier historical record of computing applications and innovations; Deloitte & Touché Fast 50 Award (1999); Technical Achievement Academy Award (1998) for designs in computer film editing equipment; National IWAY's New Technology Development Award (1997); High-Tech's Entrepreneur of the Year Award (1996); CATA's award for Best High-Tech Product (1995); Emmy Award (1994); and Canada Award for Business Excellence (Innovation-1992) for the design of industrial communications cards.

In December 2000, Mike was inducted into Maclean's Honour Roll (2000) in recognition of the Perimeter Institute, which he founded in late 2000. The Institute is dedicated to the study of fundamental issues in theoretical physics. Dr. Lazaridis attended the University of Waterloo from which he received his Honorary Doctorate of Engineering degree.

April 9, 2002

- 7:00 – 8:00 **Registration/Continental Breakfast**
- 8:15 – 8:25 **Opening Remarks**
*Arvind Chhatbar, Executive Director, Regional Innovation
Forum/President, Vitesse (Re-Skilling) Canada Inc.*
- 8:25 – 8:55 **Welcoming Remarks**
*Kirk Mandy – Co-Chair, Regional Innovation Forum and Vice
Chair, Zarlink Semiconductor*

Official Opening

Honourable Walt Lastewka, Member of Parliament, St. Catherines, standing in for Honourable Allan Rock, Minister for Industry (invited)

Keynote Speakers

8:55 – 9:35 *Our Molecular Future: How Nanotechnology, Robotics, Genetics and Artificial Intelligence Will Transform our World*
Douglas Mulhall, Foresight Institute

9:35 – 10:00 *Innovation, Convergence and Emerging Technologies*
Dr. Alan Bernstein, President, Canadian Institutes for Health Research (CIHR)

10:00 – 10:15 **Coffee Break**

10:15 – 10:40 *Building Companies with Emerging Technologies*
Dr. Brian Underdown, Vice-President, Science & Technology, MDS Capital Corp.

10:40 – 11:10 *Cluster to Cluster Linkage: Canadian Fabless Semiconductor and Taiwan's Semiconductor Fabs*
Dr. Adam Chowaniec, Chairman, Tundra Semiconductors

11:10 – 11:25 *Staying Ahead of the Game: Acting on Growth Opportunities in Emerging Technologies*
Dr. Martin Sumner-Smith, Vice-President, Pharmaceutical Solutions, OpenText Corporation, standing in for Tom Jenkins, CEO, OpenText Corporation

11:25 – 11:40 *Technology Trends*
Arup Gupta, President, TCS America, USA

11:40 – 12:00 *Connectivity in a Converging Marketplace*
Eli Turk, Vice-President, Business Development, Alcatel Canada standing in for Hubert de Pesquidoux, CEO, Alcatel Canada

12:00 – 13:30 **Lunch with Guest Speaker:**

NRC Vision to 2006
Dr. Arthur J. Carty, President, National Research Council Canada

13:30 – 15:30	Workshops
Workshop 1	Nascent Clusters: Genomics, Bioinformatics & Nanotechnology
<i>Panelists</i>	<i>Dr. Alexander Mackenzie, CHEO Research Institute</i> <i>Marc Lepage, Genome Canada</i> <i>Dr. Simon Mercer, National Research Council Canada</i> <i>Jeff Parker, Technology Partnerships Canada</i> <i>Ken Lawless, Ottawa Life Sciences Council</i> <i>Dr. David Wolfe, Innovation Research Network</i>
Workshop 2	Vital Growth Strategies: Photonics, Wireless, Fabless Semiconductor
<i>Panelists</i>	<i>Jeffrey Dale, OCRI</i> <i>Ray Novokowsky, Canadian Photonics Consortium</i> <i>Darin Graham, CITO</i> <i>Kamal Bhadada, Mobile Computing, TCS</i> <i>Tony Mascioli, Spacebridge Semiconductor</i> <i>Tim April, Business Development Bank</i> <i>Tyler Chamberlin, University of Ottawa</i>
15:30 – 16:00	Coffee Break
16:00 – 17:00	Plenary Session: Workshop Summaries
17:30 – 18:30	Cocktails
18:30 – 18:40	Welcoming Remarks for Award Ceremonies
	<i>Dr. Arthur Carty, National Research Council Canada</i> <i>Kirk Mandy, Zarlink Semiconductor</i>
18:40 – 20:20	Dinner
21:00 – 22:00	Awards Ceremony

Appendix B: Regional Innovation Awards Celebration

The Regional Innovation Forum Roundtable VII celebrated the third Regional Innovation Awards Celebration. The primary objective of this initiative is to recognize outstanding innovators and innovations for their contributions to the community through economic growth, enhancing the lifestyles of individuals in the Ottawa area and beyond, and improving the region's image as a centre of dynamic R&D.

Purpose of the Awards

The purpose of the Regional Innovation Awards is three-fold:

- To recognize the region's innovations and innovators in all areas: technology, marketing, service, etc.
- To raise the profile of individuals and innovations in the region
- To stimulate a climate for innovation in the region

Categories for the Regional Innovation Awards



Innovator of the Year

This award is given to an individual who has made the greatest contribution to innovation in the region in any field, or who has spearheaded at least one significant innovation that benefits the region from a social, economic or technological perspective.

**YEAR 2002 RECIPIENT:
CHAIM BIRNBOIM**

Dr. Chaim Birnboim set out to make it easier for pathologists to collect tissue samples – and ended up creating a dream product for forensic experts. A senior scientist at the Ottawa Regional Cancer Centre, Dr. Birnboim recently patented 'GenoFix', a DNA-fixing solution that effectively preserves tissue samples for more than one year at room temperatures. Dr. Birnboim's new company, DNA Genotek Inc., is now developing additional product lines that will simplify DNA collection and fingerprinting for forensics and law enforcement specialists.



Innovation of the Year

This award is given to a company whose innovation has had a positive economic impact on the region.

**YEAR 2002 RECIPIENT: VISTAR
TELECOMMUNICATIONS**

Vistar Telecommunications received this award due to the success of its innovation that led to the marketing of the GlobalWave, MT2000 product in the United States. The GlobalWave MT2000 terminal represents the smallest, most powerful satellite communications product available, and is capable of performing a number of functions including: transmitting information on volume, temperature, pressure and voltage; producing reports on location and speed; and triggering alarms when sensor thresholds are exceeded.



**Lifetime Achievement Award for
Innovation**

This award is given to an individual whose contribution towards the climate for innovation spans several years (more than five years) or who is a prolific innovator having been responsible for several innovations over the last five to ten years.

**YEAR 2002 RECIPIENT:
DENZIL DOYLE**

Denzil Doyle is known as the 'father of high tech' in the Ottawa region. He has been an investor in advanced technology companies for many years. He was the founding president of Digital Equipment of Canada Ltd., and has served as Chairman of Capital Alliance Ventures Inc., which has helped finance and manage the growth of many regional start-up companies. Mr. Doyle has also authored *Making Technology Happen*, a book that provides management guidance to technology entrepreneurs and investors.

Appendix C: Roundtable Participants

A

Fred Abboud
Vice President
Ernst & Young Corporate Finance
1600-100 Queen Street,
Ottawa, ON K1P 1K1
Tel: 613-598-4378
Fax: 613-232-5324
fred.abboud@ca.eyi.com

Lalita Acharya
Library of Parliament
151 Sparks Street,
Ottawa, ON K1A 0A9
Tel: 613-996-0952
Fax: 613-992-5015
acharl@parl.gc.ca

Dr. Gabrielle Adams
Director General
Institute for Biological Services, NRC
1200 Montreal Road, Bldg. M-54
Ottawa, ON K1A 0R6
Tel: 613-993-7506
Fax: 613-957-7867
gabrielle.adams@nrc.ca

Rainer Andersen
Technology Associates
Canada-Israel Industrial R&D Foundation
875 Carling Avenue, Suite 430
Ottawa ON K1S 5P1
Tel: 613-724-4569
Fax: 613-724-4569
randersen@ciirdf.ca

Nadine Apollon-Cabana
Sector Officer
Industry Canada
17th Floor, 300 Slater Street,
Ottawa ON K1A 0C8
Tel: 613-941-7625
Fax: 613-957-8839
apollon-cabana.nadine@ic.gc.ca

Tim April
BDC Venture Capital – Ottawa
55 Metcalfe St, Ground Floor,
Ottawa ON K1P 6L5
Tel: 613-947-1929
tim.april@bdc.ca

John ApSimon
Carleton University
1125 Colonel By Drive
Robertson Hall, Room 505
Ottawa ON K1S 5B6
Tel: 613-520-3973
Fax: 613-520-2681
john_apsimon@carleton.ca

David Arthurs
President
Hickling Arthurs Low
150 Isabella Street, Penthouse
Ottawa, ON K1S 1V7
Tel: 613-237-2220
Fax: 613-237-7347
darthurs@hal.ca

B

Michael Baetz
President & CEO
Ainsworth Inc.
131 Bermondsey Road
Toronto ON M4A 1X4
Tel: 416-751-4420
Fax: 416-751-7320
michael_baetz@ainsworth.com

Les Banks
Lab Director
TalentLab
4048 Carling Avenue, West
Ottawa ON K2K 1Y1
Tel: 613-271-8181
Fax: 613-271-0816
lesb@talentlab.com

Brian Barge
President and CEO
Canadian Microelectronics Corporation
210A Carruthers Hall, Queens University
Kingston ON K7L 3N6
Tel: 613-530-4653
Fax: 613-548-8104
barge@cmc.ca

Greg Barratt
President
Communitech Technology Association
435 King Street North, Suite 100
Waterloo ON N2J 2Z5
Tel: 613-888-9944 X 22
Fax: 613-888-7007
gregbarratt@communitech.org

Stephen Battah
Manager – Development
Regional Development Corporation
P.O. Box 428
Fredericton NB E3B 5R4
Tel: 506-453-2277
Fax: 506-453-7988

Jean M Bélanger
Chair, Advisory Board
ICPET
Chair, Advisory Board
Tel: 613-241-6786
jeanmbelanger@rogers.com

Robert Bell
Vice President, eGovernment
MONTAGE.DMC, eBusiness Services
A Div of AT&T Canada
360 Albert Street, Suite 1300
Ottawa, ON K1R 7X7
Tel: 613-232-2760
Fax: 613-232-3208
bob.bell@montage-dmc.com

Kevin Bell
Industrial Technology Advisor
National Research Council Canada – IRAP
1200 Montreal Road, Bldg M-55
Ottawa ON K1A 0R6
Tel: 613-993-5418
Fax: 613-952-1079
kevin.bell@nrc.ca

Alan Bernstein

President
Canadian Institute for Health Research
410 Laurier Avenue, W., 9th Floor
Ottawa, ON
Tel: 613-941-2672
Fax: 613-954-1800
abernstein@cihr.ca

Kamal Bhadada

Mobile Computing, TCS
9245 Activity Road, Suite 105
San Diego, CA USA 92126
Tel: 858-271-7510
Fax: 858-271-6494
kamal@innovatv.com

Davinder Bhalla

VP: Marketing & Technology
RNB Communications Group Incorporated
104 Delong Drive
Ottawa ON K1J 7E1
Tel: 613-741-4838
davinder@rnbgroup.ca

Adam Bielecki

Executive Director, Innovation Partnerships
& External Development
Okanagan University College
c/o President's Office, 3333 College Way,
Kelowna BC V1V 1V7
Tel: 250-470-0493

George Biljan

Technology Advisor
UWO / IRAP / NRC
800 Collip Circle,
London ON N6G 4X8
Tel: 519-430-7048
Fax: 519-430-7032
george.biljan@nrc.ca

Kathryn Bindon

President
Okanagan University College
3333 College Way,
Kelowna BC V1V 1V7
Tel: 250-470-6026
Fax: 250-470-6009
president@ouc.bc.ca
Mahmud Biswas
Vitesse (Re-Skilling) Canada Inc.
1200 Montreal Road, Building M-50,
Ottawa ON K1A 0R6
Tel: 613-746-3595 X 226
Fax: 613-746-6653
mahmud.biswas@vitesse.ca

Pam Bjornson

Director, Business Affairs
National Research Council Canada - CISTI
1500 Montreal Road, M-55,
Ottawa, ON K1A 0S2
Tel: 613-993-9637
Fax: 613-952-9112
pam.bjornson@nrc.ca

Wojtek J Bock

Directeur et professeur au Département
d'informatique
Université du Québec à Hull
C.P. 1250, succursale "B"
Hull QC J8X 3X7
Tel: 819-773-1600
Fax: 819-773-1638
bock@ugah.quebec.ca

Michael Bordt

Chief, HR & IP
Statistics Canada
7A RH Coats Building, Tunney's Pasture,
Ottawa ON
Tel: 613-951-8585
Fax: 613-951-9920
michael.bordt@statcan.ca

Nars Borodczak

Industry-University Coordinator
Trent University
1600 Westbank Drive,
Peterborough ON K9J 7B8
Tel: 416-695-2737
Fax: 416-622-5282
mborodczak@trentu.ca

Frederic Boulanger

President
Macadamian Technologies Inc.
700 Industrial Avenue, Suite 220
Ottawa ON K1G 0Y9
Tel: 613-739-5976
Fax: 613-739-9859
david@macadamian.com

Michele Boutin

Manager, Science Policy
Industry Canada
235 Queen Street
Ottawa, ON K1A 0H5
Tel: 613-952-1487
Fax: 613-996-7887
Boutin.Michele@ic.gc.ca

Peter Boyd

Senior Policy Analyst
Industry Canada
235 Queen Street, 5th Floor,
East Tower, Room 570A,
Ottawa, ON K1A 0H5
Tel: 613-941-8349
Fax: 613-941-8099
boyd.peter@ig.gc.ca

Line Brabant

President
LINE International
1264 Ben Royal Ave.
Greely ON K4P 1A3
Tel: 613-859-6308
brabants@magma.ca

Elinor Bradley

Director
Industry Canada
2nd Floor-365 Laurier Ave., W.,
Ottawa ON K1A 0C8
Tel: 613-998-0942
Fax: 613-941-8617
bradley.elinor@ic.gc.ca

Anne Brazeau Monnet
Senior Government Relations Officer
Association of Canadian Community Colleges
1223 Michael Street, North Suite 200,
Ottawa ON K1J 7T2
Tel: 613-746-2853
Fax: 613-746-6721
abrazeau-monnet@accc.ca

David Brener
Director, Industry Programs
Canadian Institute of Health Research
Tel: 613-941-6706
Fax: 613-957-8782
dbrener@cihr.ca

Peter Broadmore
Bicameral Communications
5828 Knights Drive
Manotick ON K4M 1K2
Tel: 613-859-7007
Fax: 613-859-7007
bicam@istar.ca

C

Carla Campbell
Regional Coordinator
Canadian Technology Network
3553 - 31 Street NW
Calgary AB T2L 2K7
Tel: 403-292-4240
Fax: 403-292-4255
ccampbell@ccinet.ab.ca

Mary Campbell
Solutions Manager
Next Innovations
2625 Queensview Drive
Ottawa, ON K2B 8K2
Tel: 613-726-3910
Fax: 613-726-8189
mary.campbell@nexinnovations.com

Lucie Campeau
Manager, Business Initiatives
City of Ottawa
110 Laurier Ave., West
Ottawa ON K1P 1J1
Tel: 613-580-2424 x28984
Fax: 613-560-6028
lucie.campeau@city.ottawa.on.ca

Colin S. Cantlie
Vice-President
Professional Engineers of Ontario
25 Sheppard Avenue., West, Suite 1000,
Toronto ON M2N 6S9
Tel: 613-296-9123
Fax: 613-224-0667
colin.cantlie@sumpatico.ca

Arthur J. Carty
President
National Research Council Canada
1200 Montreal Road, Bldg M-58
Ottawa ON K1A 0R6
Tel: 613-993-2024
arthur.carty@nrc.ca

Tyler Chamberlin
Prime, Faculty of Administration
University of Ottawa
Vanier Hall, 136 Jean-Macques Lussier,
Ottawa ON K1N 6N5
Tel: 613-562-5800
Fax: 613-562-5164
chamberlin@admin.uottawa.ca

Gerry Chan
Vice-President
Communications Research Centre
3701 Carling Avenue
Ottawa ON K2H 8S2
Tel: 613-998-4139
Fax: 613-990-4715
gerry.chan@crc.ca

Sylvain Charbonneau
Director, Application Technology
National Research Council Canada - IMS
Bldg M-50, 1200 Montreal Road
Ottawa ON K1A 0R6
Tel: 613-852-1106
sylvain.charbonneau@nrc.ca

Réjean Chartrand
Director, Business Development
City of Ottawa
110 Laurier Ave., West
Ottawa ON K1P 1J1
Tel: 613-580-2424 x 21696
Fax: 613-560-6028
rejean.chartran@city.ottawa.on.ca

Zhigi Chen
Associate Professor of Economics
Carleton University
1125 Colonel By Drive
Ottawa ON K1S 5B6
Tel: 613-520-2600 X7456
Fax: 613-520-3906
zchen@ccs.carleton.ca

Wally Cherwinski
National Research Council Canada

Cecillia Cheung
Alcatel Canada

Arvind Chhatbar
Executive Director, RIF
National Research Council Canada
1200 Montreal Road, Bldg M-50
Ottawa ON K1A 0R6
Tel: 613-990-9550
Fax: 613-991-6980
arvind.chhatbar@nrc.ca

Adam Chowaniec
Chairman
Tundra Semiconductor
603 March Road
Kanata ON K2K 2M5
Tel: 613-592-0714
Fax: 613-592-1320
adam.chowaniec@tundra.com

Jennifer Clancy
Business Officer
National Research Council Canada
100 Sussex Drive, Ottawa ON
Tel: 613-991-6377
jennifer.clancy@nrc.ca

Brady Clark
Sussex Research Laboratories Inc.
100 Sussex Drive, Suite 2156
Ottawa ON K1A 0R6
Tel: 613-993-4402
Fax: 613-954-5242
brady.clark@nrc.ca

William M. Coderre
Director, Corporate Development
Natural Sciences & Engineering Research Council
350 Albert Street, 13th Floor
Ottawa, ON K1A 1H5
Tel: 613-996-1403
Fax: 613-943-1624
william.coderre@nserc.ca

Phyllis Colvin
Director, Policy Division
Health Canada
Rm 9596, Brooke Claxton Bldg.
Ottawa ON K1A 0K9
Tel: 613-957-3085
Fax: 613-957-1204
phyllis.colvin@hc-sc.gc.ca

Jeanne Comeau
Doyenne/Developpement & Recherche appliquee
College communautaire du N-B Bathurst
(CCNB Bathurst)
College, communautaire due N-B. Bathurst
(CCNB Bathurst), C.P. 266,
Bathurst, NB E2A 3Z2
Tel: 506-547-7257
Fax: 506-547-7404
jeanne.a.comeau@gnb.ca

Richard Cowper
VP Global High-Capacity Transport Development
Nortel - Broadband Networks
1341 Baseline Road
Ottawa ON K2C 1A7
Tel: 613-765-2694
Fax: 613-763-5048

Robert Crawhall, PhD.
President
National Capital Institute for Telecommunications
3701 Carling Ave., Box 11480, Stn H,
Ottawa, ON K2H 8S2
Tel: 613-998-5237
Fax: 613-725-4091
crawhall@ncit.ca

Melanie Cullins
Business Development Officer
National Research Council Canada - IIT
Building M-50, Montreal Road, Room 204,
Ottawa ON K1A 0R6
Tel: 613-993-2491
Fax: 613-952-0074
melanie.cullins@nrc.ca

D

Andre Dabrowski
Vice Dean (Research)
University of Ottawa, Faculty of Science
140 Louis Pasteur St., PO Box 450 Stn A,
Ottawa ON K1N 6N5
Tel: 613-562-5986
Fax: 613-562-5193
vicedean@science.uottawa.ca

Jeffrey Dale
President and CEO
Ottawa Centre for Research and Innovation (OCRI)
36 Steacie Drive
Ottawa, ON K0A 1T0
Tel: 613-592-8160
Fax: 613-592-8163
jdale@ocri.ca

Michael Darch
Ottawa Centre for Research and Innovation (OCRI)
350 Albert Street, #1720
Ottawa, ON K1R 1A4
Tel: 613-236-3500 x.236
Fax: 613-236-9469
mdarch@ocri.ca

Brian Davies
Chief Mechanical Engineer
J.L. Richards Associates Ltd.
864 Lady Ellen Place
Ottawa ON K1Z 5M2
Tel: 613-728-3571
Fax: 613-728-6012
dweitzel@jrichards.ca

Donna DeBaeremaeker
Investment Relations Officer
Ontario Ministry of Economic Development & Trade
180 Elgin Street, Suite 810
Ottawa ON K2P 2K3
Tel: 613-241-3841 X 230
Fax: 613-241-2545
donna.debaeremaeker@edt.gov.on.ca

Danielle Delorme
Program Manager, Co-op Office
University of Ottawa
100 Thomas More, Room 432
Ottawa, ON K1N 6N5
Tel: 613-562-5800 x.3472
Fax: 613-562-5108
danielle@uottawa.ca

Don Di Salle
Director General
National Research Council Canada - Corporate
Services
1200 Montreal Road, Bldg M58
Ottawa ON K1A 0R6
Tel: 613-993-0361
Fax: 613-957-2711
don.di_salle@nrc.ca

Bill Dickie
Vice-President, Software Products
MDS Nordion
447 March Road,
Ottawa ON K2K 1X8
Tel: 613-592-2790
Fax: 613-592-6937

Dr. Elizabeth Dickson

Director of KT, Senior Policy Advisor
CIHR
410 Laurier W Ave, 9th Floor, PL 4209A,
Ottawa ON K1A 0W9
Tel: 613-954-6039
Fax: 613-954-1802
edickson@cihr.ca

Marie D'Iorio

Director, Components Technologies
National Research Council Canada - IMS
Bldg. M-50
Ottawa ON K1A 0R6
Tel: 613-993-4597
Fax: 613-957-8734
marie.d'orio@nrc.ca

Jeff Dodge

Ionalytics Inc.
1200 Montreal Rd, Bldg M-50
Ottawa ON K1A 0R6
Tel: 613-842-0977
maria.guevremont@ionalytics.com

Denzil Doyle

Chairman
Capital Alliance Ventures
600-60 Queen Street
Ottawa ON K1E 2A4
Tel: 613-567-3225 X13
Fax: 613-567-3979
ddoyle@cavi.com

Jean-Pierre Drolet, Ph.D.

Dir. De produits - Munitions petit et moyen calibre
SNC Technologies Inc.
5, Montee des Arsenaux
Le Gardeur, QC J5Z 2P4
Tel: 450-582-6268
Fax: 450-582-6268
droletj@snctec.com

Paul Dufour

Senior Program Specialist
International Development Research Centre
250 Albert Street, 12th Floor
Ottawa, ON
Tel: 613-236-6163 Ext 2166
Fax: 613-567-4478
pdufour@idrc.ca

Bernard Dumouchel

Director General
National Research Council Canada - CISTI
1200 Montreal Road
Ottawa ON K1A 0S2
Tel: 613-993-2341
Fax: 613-952-9112
bernard.dumouchel@nrc.ca

Hugh Dysart

Chief Executive Officer
Inno-centre Ottawa
120-600 Peter Morand Crescent
Ottawa ON K1G 5T3
Tel: 613-738-9550

E**Robert Eagle**

Director, Sexton Campus Research Office
Dalhousie University
P.O. Box 1000
Halifax NS B3J 2X4
Tel: 902-494-6061
Fax: 902-494-3149
robert-eagle@dal.ca

Shadia Elgazzar

Senior Research Officer
National Research Council Canada
1200 Montreal Road, Bldg M-50
Ottawa ON K1A 0R6
Tel: 613-993-6628
Fax: 613-952-7151
shadia.elgazzar@nrc.ca

Eric Elvidge

Partner
Blake, Cassels & Graydon, LLP
45 O'Connor Street
Ottawa, ON K1P 1A4
Tel: 613-788-2238
Fax: 613-788-2247
eric.elvidge@blakes.com

F. Rainer Engelhardt

Chief Executive Officer
Ottawa Biotechnology Incubation Centre Inc.
Ottawa ON
Tel: 613-224-3005
Fax: 613-224-0557
engelhardtFR@compuserve.com

Anthony Eyton

President & CEO
Precarn Incorporation
80 Aberdeen Street, #400
Ottawa ON K1S 5R5
Tel: 613-727-9576
Fax: 613-727-5672
eyton@precarn.ca

F**Jeff Favaloro**

Business Development Manager
CITO
36 Steacie Drive
Ottawa, ON K2K 2A9
Tel: 613-592-9211
Fax: 613-591-1288
jfavaloro@cito.ca

Sidney Featherman

Senior Policy Analyst, Innovation Policy Branch
Industry Canada
235 Queen Street, Room 877E
Ottawa ON K1A 0H5
Tel: 613-952-2705
Fax: 613-996-7887
featherman@sidney.ic.gc.ca

Guy Félio

Special Advisor to VP TIS
National Research Council Canada
1200 Montreal Rd., Bldg M-55
Ottawa ON K1A 0R5
Tel: 613-998-6850
Fax: 613-993-7982
guy.felio@nrc.ca

Ted Fenwick

Senior Business Analyst
Nortel Networks
3500 Carling Avenue
Ottawa, ON K2C 2H2
Tel: 613-765-6740
tfenwick@nortelnetworks.com

Scott Ferguson

Business Relations Officer
National Research Council Canada
Bldg. M-54, 1200 Montreal Road
Ottawa ON K1A 0R6
Tel: 613-990-5948
Fax: 613-952-5136
scott.ferguson@nrc.ca

Justin Ferrabee

Executive Director
Acerra - A Division of Algonquin College
200 Elgin Street
Ottawa, ON K2P 1L5
Tel: 613-727-7733 x. 4549
Fax: 727-7725
justinferrabee@acerra.ca

Kevin Fitzgibbons

Group Leader, Strategic Planning
National Research Council Canada
1500 Montreal Road, M-5B, Room E141B,
Ottawa, ON K1A 0S2
Tel: 613-990-2496
Fax: 613-941-0986
kevin.fitzpatrick@nrc.ca

Lisa Foss

Senior Economist
Finance Canada
L'Esplanade Laurier, 12th Floor E,
140 O'Connor Street
Ottawa ON K1A 0G5
Tel: 613-992-4883
Fax: 613-995-7090
foss.lisa@fin.gc.ca

Shaye Friesen

Directorate Science & Technology
Defence R&D Canada
305 Rideau Street
Ottawa ON K1A 0K2
Tel: 613-992-5676
Fax: 613-996-5177
shaye.friesen@drdc-radc.dnd.ca

Carol Furlong

Sector Officer
Industry Canada
17th Floor, 300 Slater Street
Ottawa ON K1A 0C8
Tel: 613-954-3472
Fax: 613-957-8839
furlong.carolann@ic.gc.ca

G**Barry Gander**

Senior Public Policy Advocate
Canadian Advanced Technology Alliance
388 Albert Street
Ottawa ON K1R 5B2
Tel: 613-236-6550
Fax: 613-236-8189
bgander@cata.ca

Kirsten Gartenburg

National Research Council Canada

Michel Gauthier

Directeur, Services d'Information du CNRC
ICIST/CNRC
1200 chemin Montreal,
piece 149 edifice M-55,
Ottawa, ON K1A 0S2
Tel: 613-993-3969
Fax: 613-952-8239
michel.gauthier@nrc.ca

Michel Gauvin

Director, R&D and Innovation
Dept. BNB, Province of NB
PO Box 6000
Fredericton, NB E3B 5H1
Tel: 506-444-5941
Fax: 506-457-7282
michel.j.gauvin@gnb.ca

Jean-Claude Gavrel

Directeur
Networks of Centres of Excellence
350 Albert Street,
Ottawa ON K1A 1H5
Tel: 613-996-0409
Fax: 613-992-7356
gpo@nce.gc.ca

Jocelyn Ghent Mallett

Rippon Associates Inc.
580 Prospect Avenue,
Ottawa ON K1M 0X7
Tel: 613-797-8281
Fax: 613-748-6013
jocelyngm@rogers.com

Stephane Giguere

Director, Eastern Canada
Telesat Canada
1601 Telesat Canada,
Gloucester, ON K1B 5P4
Tel: 613-748-0123
Fax: 613-748-8712
s.giguere@telesat.ca

Ed Goffin

Alcatel Canada

Simon Gosselin

CTI
National Research Council Canada - ACIP
3 Honfleur,
Candiac QC J5R 3P4
Tel: 514-996-7274
Fax: 450-632-0408

Darin Graham
President & CEO
CITO
36 Steacie Drive
Ottawa, ON K0A 1T0
Tel: 613-592-9211
Fax: 613-591-1288
dgraham@cito.ca

Prof. May Griffith
University of Ottawa Eye Institute
Ottawa Hospital – General Campus,
501 Smyth Road
Ottawa ON K1H 8L6
Tel: 613-737-8822
Fax: 613-737-8836
mgriffith@ottawahospital.on.ca

Marcelo Grinfeld
Director, Business Development
Oz Optics Limited
219 Westbrook Road,
Carp ON K0A 1L0
Tel: 613-831-0981 x 3336
Fax: 613-836-5089
marcelo@ozoptics.com

Dominique Guerin-Garnett
Institute for Information Technology, NRC

Maria Guevremont
Ionalytics Inc.
1200 Montreal Rd, Bldg M-50
Ottawa ON K1A 0R6
Tel: 613-842-0977
maria.guevremont@ionalytics.com

Roger Guevremont
President & Chief Technology Officer
Ionalytics Inc.
1200 Montreal Rd, Bldg M-50
Ottawa ON K1A 0R6
Tel: 613-842-0977
maria.guevremont@ionalytics.com

Arup Gupta
President
TCS America
101 Park Avenue, 26th Floor,
New York, NY 10178, USA
Tel: 212-557-8038
arup.gupta@usa-tes.com

Eddy Guzzo
Business Development Officer
National Research Council Canada – IMS
1200 Montreal Rd, Room 175, M-50,
Ottawa ON K1A 0R6
Tel: 613-993-1506
Fax: 613-957-8734
eddy.guzzo@nrc.ca

H

Peter Hackett
Vice-President Research
National Research Council Canada
100 Sussex Drive,
Ottawa ON K1A 0R6
Tel: 613-993-9244
Fax: 613-954-2066
peter.hackett@nrc.ca

Michael Halasz
Director, Ottawa Research
National Research Council Canada – IIT
Building M-50, Montreal Road, Room 204,
Ottawa ON K1A 0R6
Tel: 613-993-8551
Fax: 613-952-0074
michael.halasz@nrc.ca

Feridun Hamdullahpur
Vice-President Research
Carleton University
1125 Colonel By Drive, Robertson Hall, Room 607,
Ottawa ON K1S 5B6
Tel: 613-520-3570
Fax: 613-2689
feridun_hamdullahpur@carleton.ca

Sauna Hamilton
Policy Analyst
Industry Canada
856E, 235 Queen Street,
Ottawa ON K1A 0H5
Tel: 613-998-9918
Fax: 613-996-7887
hamilton.sauna@ic.gc.ca

Norine Heslton
Vice President
ITAC
Suite 500, 130 Albert Street
Ottawa ON K1P 5G4
Tel: 613-238-4822
Fax: 613-238-7967
nheslton@itac.ca

Don Hewson
Partner
Hewson Bridge & Smith
601 Bank Street,
Ottawa ON K1S 3T4
Tel: 613-238-7108
Fax: 613-238-7468
don@hbs.ca

Julia Hinde
1st Secretary, Science & Technology
British High Commission
80 Elgin Street
Ottawa ON K1P 5K7
Tel: 613-237-1542
Fax: 613-237-5211
julia.hinde@rco.gov.uk

Kathleen Hollington
Coordinator
Canada Foundation for Innovation
Tel: 613-996-5936
Fax: 613-943-0923
kathleen.hollington@innovation.ca

Joseph R.F. Hsu
Director General
Science & Technology Division, TECO
45 O'Connor Street, Suite 1960
Ottawa ON K1P 1A4
Tel: 613-231-4983
Fax: 613-231-5388

Michael Irwin
Laboratory Manager
3M Canada Company
P.O. Box 5757
London ON N6A 4T1
Tel: 519-451-2500
Fax: 519-452-6763
mirwin@mmm.com

Diane Isabelle
A/Director
IRAP/NI
1200 Montreal Road
Ottawa ON K1A 0R6
Tel: 613-993-0653
Fax: 613-952-1079
diane.isabelle@nrc.ca

George Dr. Iwama

**National Research Council Canada,
Institute for Marine Bioscience**
1411 Oxford Street
Halifax, Nova Scotia B3H 3Z1
Tel: 902-426-8278
Fax: 902-426-8514
george.iwama@nrc.ca

Erle Jones
Communications Research Centre
3701 Carling Avenue,
P.O. Box 11490, Station H
Ottawa, ON K2H 8S2
Tel: 613-998-2770
Fax: 613-998-5355
erle.jones@cbc.ca

Peter Jones
Senior Executive Officer
IP Unwired Inc.
3701 Carling Avenue, Bldg 94, 2nd Floor,
Ottawa ON K2H 8S2
Tel: 613-829-1310

John Jordan
Alcatel Canada

Hamid Jorjani
Senior Advisor
National Research Council Canada
1200 Montreal Road, M58
Ottawa, ON K1A 0R6
Tel: 613-991-5457
Fax: 613-952-9696
hamid.jorjani@nrc.ca

K

Peter Kallai
President
Keystep Growth & Finance
575 West Hunt Club, Ste 200
Ottawa ON K2G 5W5
Tel: 613-722-6500 Ext225
Fax: 613-722-4600
p.kallai@keystep.com

Dr. John Kelly
Associate Research Officer
National Research Council Canada
100 Sussex Drive
Ottawa ON K1A 0R6
Tel: 613-998-5263
Fax: 613-941-1327

Debbie Kemp
Business Development Officer
Communications Research Centre
3701 Carling Avenue
Ottawa ON K2H 8S2
Tel: 613-998-4287
Fax: 613-998-5355
debbie.kemp@nrc.ca

Karin Keyes Endemann
Director
National Research Council Canada
1200 Montreal Road, M58, Rm E301,
Ottawa ON K1A 0R6
Tel: 613-998-4579
Fax: 613-952-9696
karin.endemann@nrc.ca

David King
VP Marketing & Business Development
Galian Photonics
139 Fourth Avenue
Ottawa ON K1S 2L3
Tel: 613-565-7230
Fax: 604-742-3830
emaildking@rogers.com

Neil Knudsen
Special Advisor
Ottawa Centre for Research and Innovation (OCRI)
24 Fairfax Avenue
Ottawa ON K1Y 0T2
Tel: 613-291-9959
nknudsen@ocri.ca

Andrea Koch-Kraft
Embassy of Germany

Helmut Kungl
XYZ RGB Imaging Services
1200 Montreal Road, Bldg M-50
Room E195
Ottawa ON K1A 0R6
Tel: 613-748-9596
helmut.kungl@xyzrgb.co

L

Katie Lafferty
Executive Director
Canadian Stroke Network
451 Smyth Road
Ottawa ON K1H 8M5
Tel: 613-562-5390
Fax: 613-562-5631
klaffert@uottawa.

Lise Lafontaine
National Research Council Canada

Luc Lalonde

Director, Technology and R&D office
Carleton University
Room 1524, Dunton Tower
1125 Colonel By Drive
Ottawa, ON K1S 5B6
Tel: 613-520-2500 x.8359
Fax: 613-520-2521
luc.lalonde@carleton.ca

Bob Laliberte

National Research Council Canada

Laurent Lampron

Executive Director
S.D.E.O.
25 Laurier Street, #700
Hull QC J8X 4C8
Tel: 819-595-7336
Fax: 819-771-9846
llampron@sdeo.qc.ca

Dr. Tom Landecker

Dominion Radio Astrophysical Observatory
Box 248
Penticton BC V2A 6K3
Tel: 250-493-2277
Fax: 250-493-7767
tom.landecker@nrc.ca

Clement Langemeyer

Technology Exploitation & Entrepreneurship Advisor
National Research Council Canada –
Corporate Services
1200 Montreal Road
Ottawa ON K1A 0R6
Tel: 613-993-0736
Fax: 613-952-4569
clement.langemeyer@nrc.ca

Pierre Langevin

Alis Technologies Inc.
100 Alexis Nihon Blvd., Suite 600,
Montreal QC H4M 2P2
Tel: 514-747-2547
Fax: 514-747-2561
plangevin@alis.com

Keith Langille

President & Chief Relationship Catalyst
Texec Executive Development Centre
53 Stitt Street
Ottawa ON K2S 1C5
Tel: 613-831-7666
keith@texec.net

Dan Larkin

PharmaCap
100 Sussex Drive
Ottawa ON K1A 0R6
Tel: 613-998-3400
Fax: 613-998-9399
john.maione@pharmagap.com

Walt Lastewka, M.P.

Chair, Standing Committee on Industry, Science &
Technology
Room 561, Confederation Building,
Ottawa ON K1A 0A6
Tel: 613-992-3352
Fax: 613-947-4402
lastew@parl.gc.ca

Imants Lauks

CEO
Epocal Inc.
2319 St. Laurent Blvd.,
Ottawa ON K1G 4J8
Tel: 613-738-6192
Fax: 613-738-6195
ilauks@epocal.com

Pierre Laurin

President, Prometic Biosciences
Procrea BioSciences Inc.
6100 Royalmount Avenue,
Montreal QC H4P 2R2
Tel: 514-496-2115
Fax: 514-496-2079

Ken Lawless

Executive Director
Ottawa Life Sciences Council
600 Peter Morand Crescent, Suite 100,
Ottawa ON K1G 5Z3
Tel: 613-521-1008
Fax: 613-521-3065
kenlaw@istar.ca

Andre Lawrence

Director General
Laboratory and Scientific Services Directorate,
Canada Customs
79 Bentley Avenue
Ottawa ON K2E 6T7
Tel: 613-954-2200
Fax: 613-952-7825
andre.lab.lawrence@ccra-adrc.gc.ca

Kenneth Laycock

Manager Strategic Policy/Planning
Technology Partnerships Canada
300 Slater Street
Ottawa ON
Tel: 613-954-3779

Mike Lazaridis

President & Co-CEO
Research in Motion (RIM)
295 Phillip Street,
Waterloo ON N2L 3W8
Tel: 519-888-7465 Ext 2725
Fax: 519-888-7835
ckem@rim.net

Can Le

Manager, Economic Analysis
Industry Canada, Innovation Policy Branch
Room 867E, 235 Queen Street,
Ottawa ON K1A 0H5
Tel: 613-998-9916
Fax: 613-996-7887

Leonard Lee

President
Lee Valley Tools
1080 Morrison Drive
Ottawa ON K2H 8K7
Tel: 613-596-0350
Fax: 613-596-3073
lgl@leevalley.com

Jacques Legendre

City of Ottawa/Ville d'Ottawa

Brigitte Léger
Deputy Director – Science & Technology Division
Department of Foreign Affairs
125 Sussex Drive
Ottawa ON K1A 0G2
Tel: 613-995-2783
Fax: 613-944-2452
brigitte.leger@drait-maeci.gc.ca

Anthony G. LeMoine
Director, Finance
Ottawa Centre for Research and Innovation (OCRI)
36 Steacie Drive,
Ottawa, ON K2K 2A9
Tel: 613-592-8160
Fax: 613-592-8163
alemoine@ocri.ca

Marc Lepage
Vice-President Corporate Development
Genome Canada
155 Queen St. 9th Floor
Ottawa ON K1P 6L1
Tel: 613-751-4460
Fax: 613-751-4474
mlepage@genome.canada.ca

Peter Liebel
Ex, Technology Investment Banking
CIBC World Markets Inc.
222 Queen Street, 2nd Floor,
Ottawa ON K1P 5V9
Tel: 613-564-9610
Fax: 613-564-9752
liebel@cibc.ca

David Low
Chairman
Hickling Arthurs Low
150 Isabella Street, Penthouse,
Ottawa, ON K1S 1V7
Tel: 613-237-2220
Fax: 613-237-7347
dlow@hal.ca

Marie Lussier
Manager
CRC
3701 Carling Avenue,
Ottawa ON K2H 8S2
Tel: 613-991-1635
Fax: 613-998-2214
marie.lussier@crc.ca

Drew Lyall
Executive Director
Stem Cell Network
451 Smyth Rd.
Ottawa ON K1H 8M5
Tel: 613-562-5384
Fax: 613-562-5631
dlyall@uottawa.ca

Gerard Lynch
President & CEO
Photonics Research Ontario
60 St. George St. #129,
Toronto, ON M5S 1A7
Tel: 416-978-5758
Fax: 416-971-2117
glynch@pro.on.ca

Jacques Lyrette
Vice-President, Technology & Industry Support
National Research Council Canada
1200 Montreal Road, Bldg M55
Ottawa, ON K1A 0R6
Tel: 613-998-3664
Fax: 613-998-3839
jacques.lyrette@nrc.ca

M

Robin Mackay
Manager, Business Initiatives
City of Ottawa
110 Laurier Ave., West
Ottawa ON K1P 1J1
Tel: 613-580-2424 x 22632
Fax: 613-560-6028
robin.mackay@city.ottawa.on.ca

Alexander Mackenzie
Cheo Research Institute
401 Smyth Road, Room 139,
Ottawa ON K1H 8L1
Tel: 613-738-3683
mackenzie@cheo.on.ca

Grazia Maion
Conseillère principale à l'investissement
Fonds de Solidarité
8717 rue Berri,
Montreal QC H2M 2T9
Tel: 514-850-4820
Fax: 514-383-2615
gmaion@fondstfqc.com

Kirk Mandy
Vice-Chair
Zarlink Semiconductor
400 March Road,
Ottawa ON K2K 3H4
Tel: 613-592-0200
Fax: 613-592-1010
kirk_mandy@zarlink.com

Tsipora Mankorsky
Student Researcher
National Research Council Canada
1200 Montreal Road, Building M-50,
Ottawa ON K1A 0R6
Tel: 613-990-7661
Fax: 613-952-7151
tsipim@hotmail.com

Nick Marketios
Senior Advisor (Government & Industry)
McMaster University (Office Vice-President)
1280 Main Street West, (GH-208),
Hamilton ON L8S 4L8
Tel: 905-525-9140
Fax: 905-521-1993
market@mcmaster.ca

Claude Martel
President & CEO
Innocentre
550 Sherbrooke Street, West,
Montreal QC H3A 1B9
Tel: 514-981-9550
Fax: 514-738-9550
claudemartel@innocentre.com

Karen Martinson

Manager
CCPE 31
180-1100 Elgin Street,
Ottawa ON K2P 2K3
Tel: 613-232-2474
Fax: 613-280-5759

Tony Mascioli

Vice-President of Sales
Spacebridge Semiconductor
115 Champlain Street,
Gatineau QC J8X 3R1
Tel: 519-776-2848
Fax: 819-776-4179

Beverly McKenzie

Innovation & Network Advisor
National Research Council Canada
1200 Montreal Road, Bldg. M-55,
Room 263-D,
Ottawa ON K1A 0R6
Tel: 613-993-5364
Fax: 613-952-1079
beverly.mckenzie@nrc.ca

Aileen McManamon

Executive Director
Canadian Institute for Market Intelligence
3250 East Mall,
Vancouver BC V6T 1W5
Tel: 604-221-3162
Fax: 604-221-3124
aileen.mcmanamon@nrc.ca

Pierre Meloche

National Research Council Canada – IRAP
815 blvd. De la Carriere,
Hull QC J8Y 6T4
Tel: 819-956-7656
Fax: 819-956-7575
pierre.meloche@nrc.ca

Simon Mercer

National Research Council Canada – IMB
1411 Oxford Street,
Halifax, Nova Scotia B3H 3Z1
Tel: 902-426-4927
Fax: 902-426-9413
simon.mercer@nrc.ca

Alina Mierzwa

Policy Analyst
Industry Canada
235 Queen Stt, 5th Floor, East Tower, Room 585A,
Ottawa ON K1A 0H5
Tel: 613-946-9432
Fax: 613-941-8099
mierzwa.alina@ic.gc.ca

Carla Miner

Tel: 613-763-3548

Dr. Anton Minkov

Vitesse (Re-Skilling) Canada Inc.
1200 Montreal Road, Bldg. M-50,
Ottawa ON K1A 0R6
Tel: 613-746-3595 X 225
Fax: 613-746-6653
anton.minkov@vitesse.ca

William Minnis

Manager, Information Technology
Nunavut Arctic College/Nunavut Research Institute
PO Box 600,
Iqaluit, Nunavut X0A 0H0
Tel: 867-975-1566
Fax: 867-979-4681
wminnis@nac.nu.ca

Ingar Moen

Director Science & Technology Policy
Defence R&D Canada
305 Rideau Street,
Ottawa ON K1A 0K2
Tel: 613-992-7665
Fax: 613-996-5177
ingar.moen@drdc-rddc.dnd.ca

Robert Morais

Chief Operating Officer
DNA Genotek Inc
1552 Featherston Avenue,
Ottawa ON
Tel: 613-276-3877
Fax: 613-737-0479
morais@dnagenotek.com

Peter Morand

President
Canadian Science & Technology Growth Fund
(CSTGF)
1480 Riverside Drive, Suite 701,
Ottawa, ON K1G 5H2
Tel: 613-248-9157
Fax: 613-248-9094
pmorand@attcanada.ca

Duncan Morgan

National Training Coordinator
National Research Council Canada
503-1726 Dolphin Ave.,
Kelowna BC V1Y 9R9
Tel: 250-862-7481
Fax: 250-470-5083
duncan.morgan@nrc.ca

Rick Morgan

Partner
Ray & Berndtson
29 Beechwood Avenue,
Ottawa ON K1M 1M2
Tel: 613-742-3219
Fax: 613-742-3219
rick.morgan@rayberndtson.com

Douglas Mulhall

Foresight Institute
P.O. Box 61058,
Palo Alto, CA 94306, USA
Tel: 805-564-4401
100673.1266@compuserve.com

Robert Mundie

Officer
Privy Council Office
Blackburn Bldg, 85 Sparks Street,
Ottawa ON K1A 0R6
Tel: 613-957-5453
roxanne.rochon@nrc.ca

Fonda Munroe

Senior Veterinary Science Advisor
Canadian Food Inspection Agency
59 Camelot Drive,
Ottawa ON K1A 0Y9
Tel: 613-225-2342 X 4241
Fax: 613-228-6638
fmunroe@inspection.gc.ca

Darlene Murphy

Industry Analyst, Industry Canada
300 Slater Street,
Ottawa ON K1A 0C8
Tel: 613-941-2465
Fax: 613-952-2718
murphy.darlene@ic.gc.ca

Michael Murr

Manager, Business Facilitation
City of Ottawa
110 Laurier Ave., West,
Ottawa ON K1P 1J1
Tel: 613-580-2424 x 25195
Fax: 613-560-6028
micheal.murr@city.ottawa.on.ca

N**Eugidio Nascimento**

VP Finance, Genome Canada
155 Queen Street, 9th Floor
Ottawa ON K1P 6L1
Tel: 613-751-4460
Fax: 613-751-4474
enascimento@genomecanada.ca

Richard Nasmith

Director of Business Development,
PCI Geomatics
490 St. Joseph Blvd., Ste 400,
Gatineau QC J8Y 3Y7
Tel: 819-770-0022 X 228
Fax: 819-770-0098
nasmith@pcigeomatics.com

Guida Néné

Manager, Meetings & Communications
Photonics Research Ontario
60 St. George St. #129,
Toronto, ON M5S 1A7
Tel: 416-978-6820
Fax: 416-971-2117
gnene@pro.on.ca

Richard Normandin

Director General
National Research Council Canada - IMS
Bldg. M-50,
Ottawa ON K1A 0R6
Tel: 613-993-4449
Fax: 613-957-8734
richard.normandin@nrc.ca

Ray Novokowsky

President, Canadian Photonics Consortium
3701 Carling Avenue, Bldg 4, Room 110,
Ottawa ON K2H 8S2
Tel: 613-820-6731
Fax: 613-820-2768
ray.novokowsky@advantera.com

P**Jeff Parker**

Executive Director, Industry Canada
Technology Partnerships Canada
300 Slater Street, Ottawa, ON K1A 0C8
Tel: 613-941-6747
Fax: 613-954-9117

Richard Patten, MPP

MPP Ottawa Centre, Ontario Liberal Party
Room 434, Main Legislative Bldg.
Queen's Park, Toronto ON M7A 1A4
Tel: 416-325-1628
Fax: 416-325-1682
richard_patten-MPP@ontla.ola.org

Rosland R.P. Patterson

Commerce Officer, Sector and Corporate Analysis
Industry Canada
300 Slater St., Edmonds Tower North, Room C1760,
Ottawa ON K1A 0C8
Tel: 613-954-3459
Fax: 613-957-8839
patterson.rosalind@ic.gc.ca

Tony Patterson

Chairman, NewVid International Inc.
1480 Riverside Drive, Suite 202,
Ottawa ON K1G 5H2
Tel: 613-738-4663
tonyp09@rogers.com

John Pearce

US Business Development Division, Department
of Foreign Affairs & International Trade (NUB)
125 Sussex Drive,
Ottawa ON K1S 2K7
Tel: 613-944-9480
Fax: 613-944-9119
john.pearce@dfait-maeci.gc.ca

Roger A. Perrault

Senior Scientific Advisor, ProMetic BioSciences Inc.
6100, avenue Royalmount,
Montreal QC H4P 2R2
Tel: 514-496-2115
Fax: 514-496-2079
roger@igs.net

Donald-Daniel Picard

Director - Technology & Innovation, Economic
Development Corporation (Ville de Gatineau)
25 Laurier, 7th Floor,
Gatineau, PQ J8X 4C8
Tel: 819-595-8071
Fax: 819-595-7283
donald-daniel.picard@ville.gatineau.qc.ca

Robbyn Plumb

Manager, Policy & International Relations
NSERC/CRSNG
350 Albert Street, 13th Floor,
Ottawa, ON K1A 1H5
Tel: 613-996-0923
Fax: 613-945-5645
rmp@nserc.ca

Kent H.E. Plumley

Partner, Osler, Hoskin & Harcourt, LLP
1500 - 50 O'Connor Street,
Ottawa ON K1P 6L2
Tel: 613-235-7234
Fax: 613-235-2867
kplumley@osler.com

Ingrid Pongratz
Industry Biopharmaceutical Officer
Industry Canada
235 Queen Street
Ottawa, ON
Tel: 613-946-5593
Fax: 613-952-4209
pongatz.ingrid@ic.gc.ca

J. Andre Potworowski
TMA-Technology Management Associates
83 Placel Road,
Ottawa ON K1L 5B9
Tel: 613-580-2215
Fax: 613-560-0568
andre@tma.cc

Ian Press
Director, Data Acquisition Division
Natural Resources Canada Canada
588 Booth Street,
Ottawa ON K1A 0Y7
Tel: 613-992-2581
Fax: 613-943-8201
ian.press@ccis.nrcan.ca

Megan Price
Senior Economist
Finance Canada
L'Esplanade Laurier, 12th Floor E,
140 O'Connor Street,
Ottawa ON K1A 0G5
Tel: 613-992-2387
Fax: 613-995-7090
price.megan@fin.gc.ca

R

Dr. Jim Richards
Director, Immunochemistry Program
National Research Council Canada
100 Sussex Drive,
Ottawa ON K1A 0R6
Tel: 613-990-0854
Fax: 613-941-1327

Dr. Chris Riddle
Institute for Competitiveness & Prosperity
180 Bloor Street West, Suite 1100,
Toronto, ON M5S 2V6
Tel: 416-920-1921
Fax: 416-920-1922
c.riddle@CompeteProsper.ca

Jack Rigley
Vice-President, Satellite Communications
Communications Research Centre
3701 Carling Avenue
Ottawa ON K2H 8S2
Tel: 613-991-9309
Fax: 613-990-8842
jack.rigley@crc.ca

John Rodgers
Toth Information Systems Inc.
2045 Quincy Avenue,
Ottawa ON K1J 6B2
Tel: 613-998-9076
Fax: 613-952-8246

Laird Roe
A/Director, Science and Technology Strategy
Industry Canada
235 Queen Street, 8th Floor West,
Ottawa ON K1A 0H5
Tel: 613-998-4417
Fax: 613-996-7887
roe.laird@ic.gc.ca

Randall L. Romanin
Chief Architect, J.L. Richards Associates Ltd.
864 Lady Ellen Place,
Ottawa, ON K1Z 5M2
Tel: 613-728-3571
Fax: 613-728-6012
rromanin@jrichards.ca

Reginald Ross
VP Business Development, Image Tree
1200 Montreal Road, Bldg M-58,
Ottawa ON K1A 0R6
Tel: 613-725-4634
Fax: 613-265-4492
reg@imagetree.com
Al Rossato
ADR & Associates
Manotick ON K4M 1C6
Tel: 613-859-7007
al.rossato@sympatico.ca

Henri Rothschild
President, CIIRDF
875 Carling Avenue, Suite 430
Ottawa, ON
Tel: 613-724-1284
Fax: 613-724-1134
hrothschild@ciirf.ca

Anca Roxana Varlan
Engineering Manager, Epocal Inc.
2319 St. Laurent Blvd., Suite 500,
Ottawa ON K1G 4J8
Tel: 613-738-6192 Ext 227
Fax: 613-738-6145
avarlan@epocal.com

Jacques Ruel
Conseillère, Développement économique Canada
259, boul. St-Joseph,
Hull QC J8Y 6T1
Tel: 819-994-7442
Fax: 819-994-7846

Phil Russell
Life Sciences Branch, Industry Canada
Ottawa ON
Tel: 613-941-9218
russell.phil@ic.gc.ca

S

Raymond Sapiano
Manager, Government Sponsorships
Canadian Broadcasting Corporation
P.O. Box 3220, Stn C,
Ottawa ON K1Y 1E4
Tel: 613-724-5340
Fax: 613-724-5127
raymond-j-sapiano@cbc.ca

Jean Sarrazin
Conseiller de science et technologie
Ambassade de France

Russ Sawchuk
Director, North Carolina Canadian Office
Suite 601, 480 University Avenue,
Toronto, ON M5G 1V2
Tel: 416-348-9567
Fax: 416-348-9610
ncco@on.aibn.com

George Schoenhofer
Senior Policy Analyst
Industrial Analysis Centre, Industry Canada
235 Queen Street, Room 1068-A,
Ottawa, ON K1A 0H5
Tel: 613-954-3127
Fax: 613-941-2463
schoenhofer.george@ic.gc.ca

François Schubert
Président & Chef de la Direction
Procrea BioSciences Inc.
6100 Ave Royalmount,
Montreal QC H4P 2R2
Tel: 514-283-3401
Fax: 514-496-5288
fschubert@procrea.com

Pierre Séguin
Regional Manager, Ontario Ministry
of Economic Development & Trade
810-180 Elgin Street,
Ottawa, ON K2P 2K3
Tel: 613-241-3841
Fax: 613-241-2545
guy.desjardins@edt.gov.on.ca

Sunil Sharma
Manager, Industry Canada,
Canadian Intellectual Property Office
50 Victoria Street, 5th Floor, #513B,
Hull QC K1A 0C9
Tel: 819-953-4520
Fax: 819-997-5052
sharma.sunil@ic.gc.ca

Kanu Sikka
Business Development Officer
National Research Council Canada - IMS
1200 Montreal Road, Bldg. M-50, Room 173,
Ottawa ON K1A 0R6
Tel: 613-990-4624
Fax: 613-957-8734
kanu.sikka@nrc.ca

Michael Silverman
Senior Policy Analyst, Policy Division, Health Canada
Brooke Claxton Building, Room 962C, Postal
Locator 0909C,
Ottawa ON K1A 0K9
Tel: 613-957-3083
Fax: 613-957-1204
michael_silverman@hc-sc.gc.ca

Andre Sincennes
Senior Executive, VP, ADGA Group Consultants Inc
116 Albert Street, Suite 600,
Ottawa ON K1P 5G3
Tel: 613-237-3022
Fax: 613-237-5359
j.lavalee@adga.ca

Donald Singleton
Director General, Institute for Chemical Process
and Environmental Technology
National Research Council Canada
1200 Montreal Road, Building M-12,
Ottawa ON K1A 0R6
Tel: 613-993-4041
Fax: 613-957-8231
don.singleton@nrc.ca

Jack Smith
Leader, Corporate Strategy
National Research Council Canada
1200 Montreal Road, Bldg M-58
Ottawa, ON K1A 0R6
Tel: 613-993-7496
Fax: 613-941-0986
jack.smith@nrc.ca

Joan Smith
Director, New Program Development
Vitesse (Re-Skilling) Canada Inc.
1200 Montreal Road, Building M-50,
Ottawa ON K1A 0R6
Tel: 613-746-3595 X 224
Fax: 613-746-6652
joan.smith@vitesse.ca

Joanne Stanley
VP - Mkt & Comms., CITO
36 Steacie Drive,
Ottawa ON K2K 2A9
Tel: 613-592-9211
Fax: 613-591-1288
jstanley@cito.ca

Lois Stevenson
Director, Special Projects, Policy Sector
Industry Canada
CD Howe Blvd, 235 Queen Street, Rm 562G,
Ottawa ON K1A 0H5
Tel: 613-992-5281
Fax: 613-995-2283
stevenson.lois@ic.gc.ca

David Stevenson
Senior Advisor
National Research Council Canada
1200 Montreal Road, Bldg. M-58
Ottawa, ON K1A 0R6
Tel: 613-993-4521
Fax: 613-952-9696
david.stevenson@nrc.ca

Martin Sumner-Smith
CEO, OpenText Corporation
185 Columbia Street, West,
Waterloo ON N2L 5Z5
Tel: 519-888-7111
Fax: 519-888-0677
info@opentext.com

T

Winston Tam
Industrial Advisor
National Research Council Canada - IMS
M50, 1200 Montreal Road
Ottawa, ON K1A 0R6
Tel: 613-990-7656
Fax: 613-957-8734
winston.tam@nrc.ca

Louise-Marie Thomassin

Conseillère
Développement économique Canada
259, bou. St-Joseph,
Hull QC J8Y 6T1
Tel: 819-778-8972
Fax: 819-994-7846
louise-marie.thomassin@dec-ced.gc.ca

Dominique Tourigny

Economist
Industry Canada
885E, 235 Queen Street,
Ottawa ON K1A 0H5
Tel: 613-952-2260
Fax: 613-996-7887
tourigny.dominique@ic.gc.ca

Val Traversy

Director General & Manager
Industrial Analysis & Strategies
Industry Canada
235 Queen Street, Rm 1066B
Ottawa ON K1A 0H5
Tel: 613-954-3279
Fax: 613-941-2463
traversy.val@ic.gc.ca

Jack Treuhaff

Director, Applied Research
Algonquin College
1385 Woodroffe Avenue,
Ottawa ON K2G 1V8
Tel: 613-227-4723 Ext 5278
Fax: 613-727-79633
treuhaj@algonquincollege.com

Paul Tulonen

ITA
IRAP / NRC - OCRI
350 Albert Street, Suite 1720, Box 50,
Ottawa ON K1R 1A4
Tel: 613-236-3500 X228
Fax: 613-236-9469
paul.tulonen@nrc.ca

Deborah-Anne Tunney

Communications Officer
Institute for Microstructural Sciences
M50, 1200 Montreal Road,
Ottawa ON K1A 0R6
Tel: 613-993-4583
Fax: 613-957-8734
deb.tunney@nrc.ca

Gerry Turcotte

President, Communications Research Centre
3701 Carling Avenue,
Ottawa ON K2H 8S2
Tel: 613-990-3929
Fax: 613-998-7983
gerry.turcotte@crc.ca

Eli Turk

Vice-President, Business Development
Alcatel Canada
600 March Road, P.O. Box 13600,
Kanata ON K2K 2E6
Tel: 613-591-3600
Fax: 613-599-3626

U**Brian Underdown**

Vice-President, Science & Technology
MDS Capital Group
100 International Blvd.,
Toronto ON M9W 6J6
Tel: 416-675-7661
Fax: 416-213-4232
bunderdown@mdsintl.com

V**Mervyn Valadares**

Barrister & Solicitor
Marvysk Miller & Swain LLP/ MBM & Co.
270 Albert Street, 14th Floor,
Ottawa, ON K1P 5G8
Tel: 613-567-0762
Fax: 613-563-7671
mvaladares@mbm-law.com

Bert van den Berg

Team Leader, NSERC
rm 1478, 350 Albert Street, Tower 1,
Ottawa ON K1A 1H5
Tel: 613-992-1482
Fax: 613-995-7753
bert.vandenberg@nserc.ca

Richard J. Van Loon

President, Carleton University
1125 Colonel By Drive, Robertson Hall,
Ottawa ON K1S 5B6
Tel: 613-520-3801

Victor Varona

President, LSMS Lifesciences Mgt. Services, Inc.
300 Earl Grey Drive, Suite 511,
Kanata ON K2T 1C1
Tel: 613-599-6636
Fax: 613-599-6636
lsms@bellnet.ca

Antonio Varriano

General Manager, Operations Branch
Communications Research Centre
3701 Carling Avenue,
Ottawa ON K2H 8S2
Tel: 613-998-2768
Fax: 613-998-9875
antonio.varriano@crc.ca

Don Vernon

Manager, Technology & Innovation Policy
Industry Canada
Room 864E, 235 Queen Street,
Ottawa ON K1A 0H5
Tel: 613-990-6275
Fax: 613-996-7887
vernon.don@ic.gc.ca

W**Anne Waddell**

Manager, Federal Relations
Ontario Ministry of Economic Development & Trade
180 Elgin Street, Suite 810,
Ottawa ON K2P 2K3
Tel: 613-241-3841 X 226
Fax: 613-241-2545
anne.waddell@edt.gov.on.ca

Janet Walden
Director General,
Research Partnerships Programs, NSERC/CRSNG
350 Albert Street,
Ottawa ON K1A 1H5
Tel: 613-996-1545
Fax: 613-947-6371
janet.walden@nrc.ca

John Walden
Planning & Development Director
Town of Deep River
100 Deep River Road,
Deep River, ON K0J 1P0
Tel: 613-584-2000
Fax: 613-584-3237
jwalden@town.deepriver.on.ca

Mike Walker
Director, Business Relations Office
National Research Council Canada
1200 Montreal Road, Bldg M-58,
Ottawa ON K1A 0R6
Tel: 613-993-3733
Fax: 613-952-4569
mike.walker@nrc.ca

Pauline Walsh
Industrial Technology Advisor
National Research Council Canada – IRAP
234 Bay Street, PO Box 18,
Toronto-Dominion Centre,
Toronto ON M5K 1B2
Tel: 416-216-2128
Fax: 416-363-5988
pauline.walsh@nrc.ca

Harriet Waterman
Industrial Technology Advisor
National Research Council Canada – IRAP
IRAP Office, Queen's University,
Ellis Hall Room 439,
Kingston ON K7L 3N6
Tel: 613-533-6383
Fax: 613-533-6116
harriet.waterman@nrc.ca

David B. Watters
Assistant Deputy Minister,
Economic Development & Corp. Finance
Department of Finance
12EE 140 O'Connor Street,
Ottawa, ON K1A 0G5
Tel: 613-992-1527
Fax: 613-992-0387
watters.david@fin.gc.ca

Carl Weatherell
Carleton University
1125 Colonel By Drive, Robertson Hall,
Ottawa ON K1S 5B6
Tel: 613-520-3574
Fax: 613-520-2681
carl_weatherell@carleton.ca

Dr. Stephanie White
Osler Hoskin Harcourt, LLP
1500-50 O'Connor Street,
Ottawa ON K1P 6L2
Tel: 613-787-1140
Fax: 613-235-2867
swhite@osler.com

Don Wilford
Business Development Officer
Photonics Research Ontario
60 St George Street, #129,
Toronto ON M5S 1A7
Tel: 416-946-8922
Fax: 416-946-8915
ovelarde@pro.on.ca

David A. Wolfe
Prof. Of Political Science & Co-Director
University of Toronto
1 Devonshire Place, 3675,
Toronto ON M5S 3K7
Tel: 416-946-8922
Fax: 416-946-8915
david.wolfe@utoronto.ca

Andrew Woodsworth
Director, National Research Council Canada – IIT
Building M-50, Montreal Road, Room 204,
Ottawa ON K1A 0R6
Tel: 613-993-9010
Fax: 613-952-0074
andrew.woodsworth@nrc.ca

David Woynorowski
Loan Fund Manager
Western Economic Diversification
1500 Canada Place, 9700 Jasper Avenue,
Edmonton AB T5J 4H7
Tel: 780-495-4970
Fax: 780-495-6876
david.woynorowski@wd.gc.ca

Dr. Wright
University of Ottawa
1855 Camborne Crescent,
Ottawa ON K1H 7B6
Tel: 613-562-5800
dwright@uottawa.ca

X

Peter Xiong
Biocyber Technologies Inc.
PO Box 58022,
Orleans ON K1C 7H4
Tel: 613-291-8189
Fax: 613-834-4193

